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ABSTRACT

This manual presents practical advice on planning and adopting an integrated pest management (IPM) program for Pennsylvania educational facilities. The manual covers how to implement a school IPM, school IPM operational information for the school administrator, and technical information for Pennsylvania schools concerning various pests found in and around schools and their prevention and control. A list of literature resources cited in the manual is provided as are lists of additional references and resources and supplemental materials to help develop IPM programs in Pennsylvania schools. (GR)

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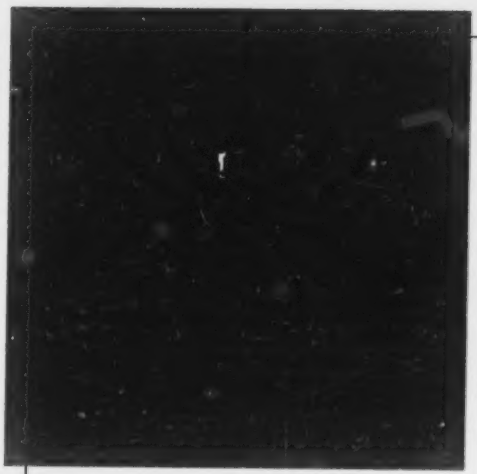
IPM for Pennsylvania Schools

A HOW-TO MANUAL



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IPM for Pennsylvania Schools

A HOW-TO MANUAL

Produced by the Pennsylvania Integrated Pest Management Program

Pennsylvania Agriculture
Products for the Planet
Pennsylvania Department of Agriculture

PENNSTATE
College of
Agricultural Sciences
Cooperative Extension

PA IPM

The PA IPM Program
is a collaboration between the
Pennsylvania Department of Agriculture and
The Pennsylvania State University
aimed at promoting
Integrated Pest Management
in both agricultural and nonagricultural settings.

As part of the PA IPM Program,
the Pennsylvania Department of Agriculture,
the Pennsylvania Department of Education,
the Pennsylvania Department of Health, and
The Pennsylvania State University
Colleges of Agricultural Sciences and Education
signed a memorandum of understanding to promote
IPM implementation in schools.
PA IPM drew on this partnership to develop
this manual.

DEPARTMENT OF
HEALTH
...in pursuit of good health

Pennsylvania Department of Education

Preface

The Pennsylvania Integrated Pest Management (PA IPM) Program was given the responsibility by the Secretary of the Pennsylvania Department of Agriculture to develop this practical manual, which will aid Pennsylvania schools in adopting an integrated pest management (IPM) program.

Integrated Pest Management (IPM) is a scientific, step-wise approach to pest management. IPM steps "integrate" knowledge of pest identity and biology with pest monitoring so that actions, if any, can be taken at just the right time. In addition, the IPM approach uses a combination of management tactics (biological, cultural, physical, and chemical) that are most likely to be safe and effective in a particular pest scenario. Prevention and early intervention is emphasized to avoid pest outbreaks.

Although many quality materials on integrated pest management in schools have been developed in other states and at the national level, PA IPM sought to design a manual specifically for Pennsylvania schools. With this in mind, appropriate materials from many sources were gathered and modified to meet Pennsylvania laws and regulations, conditions, and pest problems. A primary source of information was *IPM for Schools: A How-to Manual*, published by the United States Environmental Protection Agency.

We hope this manual will encourage schools to develop their own IPM programs and train their personnel to become familiar with IPM practices. Some personnel may wish to be trained as certified pesticide applicators. **Recommendations given in this manual are current as of January 2001.**

For further information concerning IPM, visit the PA IPM Web site: **http://paipm.cas.psu.edu**.

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Getting Started With School IPM

Many states are beginning to adopt integrated pest management (IPM) practices in school facilities. IPM is a decision-making process that emphasizes practices which quite often lead to a decrease in the amount of pesticide used. It manages pests through sanitation, exclusion, and nonchemical devices rather than depending exclusively on pesticides. IPM uses information about pests' life cycles to manage them with the least impact on people and the environment.

Pests are any living organisms that negatively affect humans or their property. Pests include weeds and plant diseases, as well as insects that feed on plants or stored products, transmit pathogens, or are nuisances. Other animals, such as snails, ticks, mites, mice, rats, groundhogs, pigeons and deer, can become pests in certain situations.

IPM begins with prevention.

An essential element of IPM is to identify the root cause of pest problems at a particular site. Understanding what pests need in order to survive is the key. Pests live in areas that provide basic needs such as food, water, and shelter, so they often can be managed by removing one or more of these necessities, such as food and water sources, or by closing off entry points into buildings.

Proper design of new construction and prompt repairs and building maintenance are essential.

Another essential element of IPM is monitoring on an ongoing basis to determine pest severity.

The judicious use of pesticides is a part of an IPM program when monitoring indicates they are needed and necessary.

A fourth essential element of IPM is the involvement of the entire school community. In addition, some staff should be trained in IPM implementation procedures.

Whether an IPM program raises or lowers costs depends on housekeeping, maintenance, and pest management policies. The costs of setting up an IPM program also can depend on whether pest management services are contracted out or provided by in-house staff. *Be aware that Pennsylvania law requires in-house personnel to become certified by the Pennsylvania Department of Agriculture before they can apply pesticides.*

Typically, implementing an IPM program may cost more at first because prevention and facilities maintenance may need to be instituted. However, after the prevention activities have been completed, IPM costs should be lowered due to reduced access by pests. New building design should take pest management factors into consideration.

Schools should follow these steps in starting an IPM program:

1. Develop an IPM Policy Statement

The policy statement should explain what is expected, how existing services will be included, and how students and staff can take part in the program.

A model policy statement (Policy 716 – Integrated Pest Management in Schools) developed by the Pennsylvania Integrated Pest Management (PA IPM) Program and the Pennsylvania School Boards Association is found on pages 9 and 10.

2. Set Pest Management Objectives

Examples of pest management objectives include:

- designing new facilities and structures to prevent pest occurrence and damage
- managing pests that may interfere with learning in a facility
- eliminating the possibility of injury to students and staff
- preserving the integrity of buildings
- maintaining sports fields
- responding to children's health issues and preventing the spread of disease
- communicating about the IPM program with administrators, teachers, parents, students, and maintenance personnel

3. Designate Pest Management Roles

Designating roles for the pest management professionals (PMP), staff, students, and parents is an important part of an IPM program. Cooperation is critical. The more students and staff join in, the better an IPM program will work.

- **IPM Coordinator**. Each district should designate one individual as the district coordinator for the IPM program. In districts with more than one building,

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Adapted for Pennsylvania schools from the University of Florida School IPM Web site article *Getting Started with School IPM* at **http://schoolipm.ifas.ufl.edu/doc/started.htm**

each building should designate a person to interact with the district IPM coordinator.

- **IPM Advisory Committee**. Some schools have found it helpful to establish an advisory committee to facilitate communication. It could include parents, teachers, kitchen and maintenance personnel, and other interested persons.
- **Students and Staff**. The most important job for students and staff is to help in keeping the school clean. Preventing pests depends on everyone working together to clean up litter and leftover food.
- **Parents**. Parents' first school pest management responsibility is to learn about and follow IPM practices at home. Pests carried from home in notebooks, lunchboxes, or clothing can slow the success of an IPM program.
- **Pest Manager or Contractor**. The pest manager (in-house personnel certified as a pesticide applicator in Category 23 of [7 PA. Code §128.42]) or contractor (certified pesticide applicator hired from outside the system) is the person who inspects the facility, monitors for pests, and decides if prevention or suppression measures are necessary. The pest manager also keeps records of any pesticide use, including the kind and EPA Registration number, amount, location, and dates of application.

4. Set Action Thresholds

The mere presence of a pest does not always require the application of a pesticide. The pest manager and school staff should decide in advance how many pests are harmless and how many require management (in other words, how many can be tolerated). This is called the "action threshold" for management of a particular pest.

5. Inspect Sites and Monitor for Pests

Inspecting sites for pests or pest-promoting situations is an important part of IPM. The pest manager should identify any pests found and attempt to determine where they came from. Structural and maintenance changes to the building may then be used to reduce pest numbers.

Monitoring traps are placed in areas where pests have been reported. The numbers of pests caught are counted to determine if action thresholds (the amount of pests that can be tolerated) have been reached and suppression measures are necessary.

6. Apply IPM Management Strategies

When the number of pests exceeds the preset action threshold, the pest manager takes action. The pest manager may physically remove the pests or suggest habitat modifications that would prevent pests from finding food, shelter, and water. Other management strategies used in an IPM program may include building repair, improved sanitation, or a targeted application of an appropriate pesticide.

7. Evaluate Results and Keep Records

Accurate record keeping allows the pest manager to evaluate the success of the IPM program. Records also help in forecasting when a seasonal pest may appear or when an outbreak may occur.

After a period of time, people involved with the program will gain a sense of IPM activity priorities. For example, any garbage or trash that may attract pests in and around the building must be removed daily.

IPM record keeping activities

Keep **pest sighting logs** in each room and check them on a weekly basis. Depending on circumstances, sticky traps or glue boards used for monitoring cockroaches or mice should be checked as needed.

Regular (monthly) flashlight inspections of kitchen areas, behind appliances, sinks, soda machines, storage facilities, and other areas may be needed to locate cockroaches, silverfish, and ants. The cafeteria inspection check list on pages 18 and 19 can be used for these inspections.

Depending on individual school situations, an **annual inspection** of athletic fields, turf, and ornamental plants may be sufficient. If records have been kept showing past pest problems, the inspection may be adjusted to monthly or weekly as needed.

Seasonal inspections may be helpful in preventing some problems. In the fall, at the beginning of the school year, many outside pests begin to migrate indoors. Be alert to prevent their entry into buildings. In spring, birds may attempt to nest in building corners or openings, increasing the possibility of parasitic bird mites entering buildings.

Needed **structural repairs** should be made as soon as feasible to minimize pest entry. Check for gaps around doors, pipes, and wires in walls, torn screens, cracks in walls, and other flaws that could give pests access.

Consider creating a **student "Pest Patrol" club** to monitor various areas of the building and grounds for pests. Many eyes will spot potential pest problems more efficiently than one person can.

The IPM coordinator, teachers, students, parents, and administrators need to **communicate regularly** about perceived problems.

School Integrated Pest Management Information for the School Administrator

The Pennsylvania Integrated Pest Management Program has prepared this manual to help your school establish an Integrated Pest Management (IPM) Program. This section is directed at the school administrator and contains several documents, listed below, which should be used as part of an IPM plan. Several of the documents have been adapted from the University of Florida School IPM Web site (see page 105).

Policy Statement

A Model Integrated Pest Management Policy for Schools

The first step in an IPM program is to establish a school policy and inform teachers, staff, and students about it. The notice can be printed and posted on bulletin boards for all to see (page 8).

Contracts

Contract Guide Specification for Integrated Pest Management Programs in Pennsylvania Schools

School officials may find these guidelines useful when creating bid specifications for integrated pest management proposals from vendors. These specifications are provided as a starting point for schools that outsource pest management. If used as a template for contracts, these guidelines should provide the pest manager with descriptions and details sufficient to deliver quality IPM in schools (page 11).

Forms

Integrated Pest Management Pest Sighting Log

A pest sighting log should be kept at each facility, building, floor, or room, depending on your specific IPM plan. An individual (the district IPM coordinator or building coordinator) should be responsible for this document. All employees in the given area should know to report any pest sightings to this person. The pest manager reviews this document at the beginning of each visit and responds appropriately. Any treatments should be recorded in this document by the pest manager. Review of this form should be included as part of the pest management operator's periodic inspection process (page 17).

Integrated Pest Management Cafeteria Inspection Checklist

Because food handling areas tend to be the source of many pest infestations, a separate inspection form is provided for cafeterias. The pest manager can use this document to ensure that a thorough inspection has been completed. One of these checklists should be completed during each inspection. The pest manager should not limit the inspection solely to what is indicated on the checklist. The IPM coordinator should review the pest manager's comments on the checklist and take appropriate action (page 18).

Intent to Apply Pesticides

The application of a pesticide in a school environment is a last-resort management option. It is important to make teachers and staff aware when this type of application is necessary. The "Intent to Apply Pesticides" form should be completed by the pest manager and submitted to the IPM coordinator before treatment (page 20).

NOTE: all pesticide application in schools is regulated by state laws, which are subject to change. To ensure compliance, check with the Pennsylvania Department of Agriculture for current regulations.

A Model Integrated Pest Management Policy for Schools

Developed by the Pennsylvania IPM Program and the Pennsylvania School Boards Association

May 1999

Policy 716

Integrated Pest Management in Schools

The perceived impact on children of pesticide use on school grounds has stimulated political activity and interest in Integrated Pest Management (IPM). As part of this public discussion, the implementation of IPM has been forwarded by citizens' groups and government alike as a means of reducing many of the concerns associated with pesticides. The Pennsylvania Integrated Pest Management Program (PA IPM) has responded to this phenomenon in several ways.

PA IPM is a collaboration between Penn State's College of Agricultural Sciences and the Pennsylvania Department of Agriculture. All PA IPM activities and responsibilities are a product of this collaboration. The School IPM Program has two main thrusts. The first is to facilitate the implementation of IPM strategies to manage pests on school grounds. The second is to move IPM principles and activities into the K-12 curriculum as an example of interdisciplinary, environment-oriented problem solving. IPM is included in the new academic standards for Environment and Ecology, (Public School Code of 1949 (24 P. S. §§ 1-101—27-2702) [22 PA. CODE CH. 4. Academic Standards and Assessment]).

You can view the standards on the Web at http://paipm.cas.psu.edu/standards.html. In addition, the Department of Education, the Department of Health, and Penn State's College of Education have joined the Department of Agriculture and Penn State's College of Agricultural Sciences in a Memorandum of Understanding to promote IPM in schools.

A committee of staff members from the Pennsylvania School Boards Association and the Pennsylvania Integrated Pest Management Program collaborated to draft material to assist school boards and administrators in implementing IPM.

In addition to deciding about adopting an IPM policy, a school board should consider the following:

1. Designate a school district employee to be IPM coordinator.
2. Form a stakeholder advisory group that may consist of parents, students, teachers, school maintenance personnel, school administrators, pest management professionals, air quality experts, etc.
3. Write an IPM policy pursuant to local needs and conditions.

The following model policy and implementation procedures are provided for your information and assistance in preparing and executing a school district IPM policy. Each school district should determine the policy and procedures most appropriate for its needs, in consultation with the district's solicitor.

SECTION: PROPERTY
TITLE: INTEGRATED PEST MANAGEMENT
ADOPTED: _____
REVISED: _____

716. Integrated Pest Management

1. Purpose
Title 22
Sec. 4.12
Pol. 102

The school district shall utilize integrated pest management procedures to manage structural and landscape pests and the toxic chemicals used for their control in order to alleviate pest problems with the least possible hazard to people, property, and the environment.

The district shall integrate IPM education into the curriculum in accordance with relevant academic standards.

2. Definition

Integrated Pest Management (IPM) is the coordinated use of pest and environmental information to design and implement pest control methods that are economically, environmentally, and socially sound. IPM promotes prevention over remediation, and it advocates the integration of at least two (2) or more strategies to achieve long-term solutions.

3. Authority
3 P.S.
Sec. 111.21–111.61
7 Pa. Code
Chap. 128

The Board establishes that the school district shall use pesticides only after consideration of the full range of alternatives, based on analysis of environmental effects, safety, effectiveness, and costs.

4. Delegation of Responsibility

The Superintendent or designee shall be responsible to implement integrated pest management procedures and to coordinate communications between the district and the approved contractor.

The Board shall designate an employee to serve as IPM coordinator for the district.

5. Guidelines	Pest management strategies may include education, exclusion, sanitation, maintenance, biological and mechanical controls, and site appropriate pesticides. An integrated pest management decision shall consist of the following five (5) steps: 1. Pest species identification. 2. Estimate pest populations and compare to established action thresholds. 3. Select the appropriate management tactics based on current on-site information. 4. Assess effectiveness of pest management. 5. Keep appropriate records. The district shall establish and maintain accurate records of all pest management activities, including pest surveillance, structural repairs and modifications, trapping, baiting, and pesticide applications. All appropriate personnel involved in making pest management decisions shall take part in update training. An Integrated Pest Management Program shall include the education of staff, students, and the public about IPM policies and procedures. Information regarding pest management activities, including pesticide use, shall be available to the public at district administrative offices. Page 2 of 2 (PSBA Policy Guide for Pennsylvania Schools, Section: Property, Title: 716. Integrated Pest Management)

Contract Guide Specification for Integrated Pest Management Programs

This document is intended for general guidance only and does not pertain to any actual contract. Contract details need to be adapted to the local circumstances.

1. GENERAL

a. Description of Program

This specification is part of a comprehensive Integrated Pest Management (IPM) program for the premises listed herein. The goal of IPM is to achieve long-term, environmentally sound pest suppression through the use of effective management practices. Management strategies in an IPM program begin with prevention, including structural and procedural modifications that reduce the food, water, and harborage used by pests, and the judicious use of pesticides when need is indicated by monitoring.

b. Contractor Service Requirements

The Contractor shall furnish all supervision, labor, materials, and equipment necessary to accomplish the surveillance, trapping, pesticide application, and pest removal components of the IPM program. The Contractor shall also provide detailed, site-specific recommendations for structural and procedural modifications to aid in pest prevention. **Note:** The buildings or partial areas within each building included in this contract are: (*list buildings/partial areas [pool, kitchens, and other areas] here*).

2. PESTS INCLUDED AND EXCLUDED

a. The Contractor Shall Adequately Suppress the Following Pests

i. Indoor populations of rats, mice, cockroaches, ants not included in **b. iii**, fleas, stinging wasps, spiders, and any other arthropod pests not specifically excluded from the contract.

ii. Populations of the above pests that are located outside of the specified buildings, but within the immediate exterior perimeter of the buildings.

b. Populations of the Following Pests Are Excluded from This Contract and Must Be Separately Negotiated:

i. Birds, bats, snakes, and all other vertebrates other than commensal rodents.

ii. Termites and other wood-destroying organisms.

iii. Carpenter ants, Pharaoh ants, and Odorous house ants.

v. Mosquitoes.

vi. Invasions of seasonal or overwintering arthropods such as millipedes, box elder bugs, lady beetles, cluster flies, or other miscellaneous flying insects.

vii. Pests that primarily feed on outdoor vegetation.

viii. Stored products pests.

3. INITIAL BUILDING INSPECTIONS

The Contractor shall complete a thorough initial inspection of each building or site prior to the starting date of the contract. The purpose of the initial inspection is for the Contractor to evaluate the pest management needs of all premises and to identify problem areas and any equipment, structural features, or management practices that are contributing to pest infestations. Access to building space shall be coordinated with the IPM Coordinator. The IPM Coordinator will inform the Contractor of any restrictions or areas requiring special scheduling.

4. PEST MANAGEMENT PLAN

The Contractor shall submit to the IPM Coordinator a Pest Management Plan at least five (5) working days prior to the starting date of the contract. Upon receipt of the Pest Management Plan, the IPM Coordinator will render a decision regarding its acceptability within five (5) working days. If aspects of the Pest Management Plan are incomplete or disapproved, the Contractor shall have five (5) working days to submit revisions. The Contractor shall be on-site to perform the initial service visit for each building within the first thirty (30) working days of the contract.

The Pest Management Plan shall consist of five parts as follows:

a. Proposed Materials and Equipment for Service

The Contractor shall provide current labels and Material Safety Data Sheets (MSDS Sheets) of all

Adapted for Pennsylvania schools from the University of Florida School IPM Web site article *Contract Guide Specification for Integrated Pest Management Programs in Government Buildings and Schools* at **http://schoolipm.ifas.ufl.edu/doc/contract.pdf**, October 1998.

pesticides to be used, and brand names of pesticide application equipment, rodent bait stations, insect and rodent trapping devices, pest monitoring devices, pest surveillance and detection equipment, and any other pest management devices or equipment that may be used to provide service.

b. Proposed Methods for Monitoring and Surveillance

The Contractor shall describe methods and procedures to be used for identifying sites of pest harborage and access, and for making objective assessments of pest population levels throughout the term of the contract.

c. Service Schedule for Each Building or Site

The Contractor shall provide complete service schedules that include specific day(s) of the week of Contractor visits and the approximate time of each visit.

d. Description of any Structural or Operational Change That Would Facilitate the Pest Management Effort

The Contractor shall describe site-specific solutions for observed sources of pest food, water, harborage, and access.

e. Commercial Pesticide Applicator Certificates or Licenses

The Contractor shall provide photocopies of the pest control company's BU number and Pesticide Applicator Certificate or Technician Registration for every Contractor employee who will be performing on-site service under this contract.

The Contractor shall be responsible for carrying out work according to the approved Pest Management Plan. The Contractor shall receive the concurrence of the IPM Coordinator prior to implementing any subsequent changes to the approved Pest Management Plan, including additional or replacement pesticides and on-site service personnel.

5. RECORD KEEPING

The Contractor shall be responsible for maintaining a pest management logbook or file for each building or site specified in this contract. These records shall be kept on site and maintained on each visit by the Contractor. Each logbook or file shall contain at least the following items:

a. Pest Management Plan

A copy of the Contractor's approved Pest Management Plan, including labels and MSDS sheets for all pesticides used in the buildings, brand names of all pest management devices and equipment used in the buildings, a plot plan of rodent management devices with service/install protocols, and the Contractor's service schedule for the buildings.

b. Work Request and Inspection Forms

Work Request and Inspection Forms will be used to advise the Contractor of routine service requests and to document the performance of all work, including emergency work. Upon completion of a service visit to the building or site, the Contractor's employee performing the service shall complete, sign, and date the form, and return it to the logbook or file on the same or succeeding day of the service rendered.

c. Contractor's Service Report Forms

Customer copies of a Contractor's Service Report Form documenting all information on pesticide application.

6. MANNER AND TIME TO CONDUCT SERVICE

a. Time Frame of Service Visits

Title 7, Pesticide Rules and Regulations (§ 128.106, see page 109) prohibit the Contractor from applying a pesticide in a common access area within a building when students are expected to be in the common access area for normal academic instruction or organized extracurricular activities within seven (7) hours following the application. When it is necessary to perform work outside of the regularly scheduled hours set forth in the Pest Management Plan, the Contractor shall notify the IPM Coordinator in advance.

b. Safety and Health

i. The Contractor shall observe all safety precautions throughout the performance of this contract. All work shall comply with the **PENNSYLVANIA PESTICIDE CONTROL ACT OF 1973 AND TITLE 7—AGRICULTURE, DEPARTMENT OF AGRICULTURE, PART V. BUREAU OF PLANT INDUSTRY, PESTICIDES RULES AND REGULATIONS** and municipal safety and health requirements. Where there is a conflict between applicable regulations, the most stringent will apply.

ii. The Contractor shall assume full responsibility and liability for compliance with all applicable regulations pertaining to the health and safety of personnel during the execution of work.

c. Special Entrance

Certain areas within some buildings may require special instructions for persons entering them. Any restrictions associated with these special areas will be explained by the IPM Coordinator. The Contractor shall adhere to these restrictions and incorporate them into the Pest Management Plan.

d. Uniforms and Protective Clothing

All Contractor personnel working in or around buildings designated under this contract shall wear distinctive uniform clothing. The Contractor shall determine the need for and provide any personal protective items required for the safe performance of work. Protective clothing, equipment, and devices shall comply with FIFRA and the specific pesticide labels.

e. Vehicles

Vehicles used by the Contractor shall be identified in accordance with Commonwealth of Pennsylvania regulations. All vehicles will be locked when unattended on client property.

7. SPECIAL REQUESTS AND EMERGENCY SERVICE

On occasion, the IPM Coordinator may request that the Contractor perform corrective, special, or emergency service(s). The Contractor shall respond to these exceptional circumstances and complete the necessary work within one (1) working day after receipt of the request. If the emergency service involves wasps or yellowjackets, it should be on a "same day" response when the call is made. In the event that such services cannot be completed within one working day, the Contractor shall immediately notify the IPM Coordinator and indicate an anticipated completion date.

8. CONTRACTORS AND CONTRACTOR PERSONNEL

All Contractors must be licensed as a qualified pest control business with the Pennsylvania Department of Agriculture (PDA).

Throughout the term of this contract, all Contractor personnel providing on site pest management service must maintain and possess certification or registered technician cards issued by PDA.

At the discretion of the School District, the Contractor personnel may need a criminal background check (Act 34 clearance), child abuse background check (Act 151 clearance), and, if from out of state, an FBI fingerprint card.

9. USE OF PESTICIDES

The Contractor shall be responsible for application of pesticides according to the label. All pesticides used by the Contractor must be registered with the U.S. Environmental Protection Agency (EPA) and PDA. Transport, handling, and use of all pesticides shall be in strict accordance with the manufacturer's label instructions and all applicable federal, state, and local laws and regulations.

The Contractor shall adhere to the following rules for pesticide use:

a. Approved Products

The Contractor shall not apply any pesticide product that has not been included in the Pest Management Plan or approved in writing by the IPM Coordinator.

b. Pesticide Storage

The Contractor shall not store any pesticide product on the premises listed herein.

c. Application by Need

Pesticide application shall be according to need and not by schedule. As a general rule, application of pesticides in any inside or outside area shall not occur unless visual inspections or monitoring devices indicate the presence of pests in that specific area. Preventive pesticide treatments of areas where surveillance indicates a potential insect or rodent infestation are acceptable on a case-by-case basis.

d. Minimizing Risk

When pesticide use is necessary, the Contractor shall employ products that pose minimum risk, have the most precise application technique, and need the minimum quantity of pesticide to achieve adequate pest management.

e. "Intent to Apply Pesticides"

This form should be given to the IPM Coordinator prior to application, appropriately posted, and students and staff on the Pennsylvania Pesticide Hypersensitivity Registry notified not less than 12 hours and not more than 72 hours prior to the pesticide application.

10. INSECT MANAGEMENT

a. Emphasis on Non-pesticide Methods

The Contractor shall use non-pesticide methods of management wherever possible. For example:

i. Portable vacuums rather than pesticide sprays should be strongly considered for initial cleanouts of cockroach infestations, for swarming (winged) ants and termites, and for management of spiders in webs wherever appropriate.

ii. Trapping devices, rather than pesticide sprays, shall be used for indoor fly management wherever appropriate.

b. Application of Insecticides to Cracks and Crevices

As a general rule, the Contractor shall apply all insecticides as "crack and crevice" treatments only (application with a tool or nozzle specifically designed for crack and crevice injection), defined in this contract as treatments in which the formulated insecticide is not able to be contacted or is not visible to a bystander during or after the application process.

c. Application of Insecticides to Exposed Surfaces

Application of insecticides to exposed surfaces shall be restricted to unique situations where no alternative measures are practical. The Contractor shall obtain the approval of the IPM Coordinator prior to any application of insecticide to an exposed surface treatment. No surface application shall be made while tenant personnel are present. The Contractor shall take all necessary precautions to ensure tenant and employee safety, and all necessary steps to ensure the containment of the pesticide to the site of application.

d. Insecticide Bait Formulations

Bait formulations shall be used for cockroach, fly, and ant management wherever appropriate, and must be inaccessible to children.

e. Monitoring

Sticky traps shall be used to guide and evaluate indoor insect management efforts wherever necessary.

11. RODENT MANAGEMENT

a. Indoor Trapping

As a general rule, rodent management inside occupied buildings shall be accomplished with trapping devices only. All such devices shall be concealed out of the general view and in protected areas so as not to be affected by routine cleaning and other operations. Trapping devices shall be checked on a schedule approved by the IPM Coordinator. The Contractor shall be responsible for disposing of all trapped rodents and all rodent carcasses in an appropriate manner.

b. Use of Rodenticides

In exceptional circumstances, when rodenticides are deemed essential for adequate rodent management inside occupied buildings, the Contractor shall obtain the approval of the IPM Coordinator prior to making any interior rodenticide treatment. All rodenticides, regardless of packaging, shall be placed either in locations not accessible to children, pets, wildlife, and domestic animals, or in EPA-approved, tamper-resistant bait stations. As a general rule, rodenticide application outside buildings shall emphasize the direct treatment of rodent burrows wherever feasible.

c. Use of Bait Stations

Frequency of bait station servicing shall depend upon the level of rodent infestation. A suggested minimum is at least one time per month. All bait stations shall be maintained in accordance with EPA regulations, with an emphasis on the safety of non-target organisms. The Contractor shall adhere to the following five points:

i. All bait stations shall be placed out of the general view, in locations where they will not be disturbed by routine operations.

ii. The lids of all bait stations shall be fastened with a lock or hexhead screw only.

iii. All bait stations shall be securely attached or anchored to the floor, ground, wall, or other immovable surface, so that the station cannot be picked up or moved.

iv. Bait shall always be placed on mounting rods within the baffle-protected feeding chamber of the station and never in the runway of the station.

v. All bait stations shall be labeled on the inside with the Contractor's business name and address, emergency phone number, rodenticide type, and active ingredient, and shall be dated by the Contractor's employee at the time of installation and each servicing.

12. STRUCTURAL MODIFICATIONS AND RECOMMENDATIONS

Throughout the term of this contract, the Contractor shall be responsible for advising the IPM Coordinator about any structural, sanitary, or procedural modifications that would reduce pest food, water, harborage, or access. The Contractor shall be responsible for adequately suppressing all pests included in this contract regardless of whether or not the suggested modifications are implemented. The Contractor will not be held responsible for carrying out structural modifications as part of the pest management effort unless specified by the contract. However, minor applications of caulk and other sealing materials by the Contractor to eliminate pest harborage or access may be approved by the IPM Coordinator on a case by case basis. The Contractor shall obtain the approval of the IPM Coordinator prior to any application of sealing material or other structural modification.

13. PROGRAM EVALUATION

The IPM Coordinator will continually evaluate the progress of this contract in terms of effectiveness and safety and will require such changes as are necessary. The Contractor shall take prompt action to correct all identified deficiencies.

14. QUALITY CONTROL PROGRAM

The Contractor shall establish a complete quality control program to assure the requirements of the contract are provided as specified. Within five (5) working days prior to the starting date of the contract, the Contractor shall submit a copy of his program to the IPM Coordinator. The program shall include at least the following items:

a. Inspection System

The Contractor's quality control inspection system shall cover all the services stated in this contract. The purpose of the system is to detect and correct deficiencies in the quality of services before the level of performance becomes unacceptable and/or the IPM Coordinator identifies the deficiencies.

b. Checklist

A quality control checklist shall be used in evaluating contract performance during regularly scheduled and unscheduled inspections. The checklist shall include every building or site serviced by the Contractor as well as every task required to be performed.

c. File

A quality control file shall contain a record of all inspections conducted by the Contractor and any corrective actions taken. The file shall be maintained throughout the term of the contract and made available to the IPM Coordinator upon request.

d. Inspector(s)

The Contractor shall state the name(s) of the individual(s) responsible for performing the quality control inspections.

Forms

The forms on the following four pages are intended to help school administrators and pest managers with record-keeping and inspection activities.

They include:

Integrated Pest Management Pest Siting Log

PAGE 17

This form can be provided to teachers, maintenance staff, cafeteria personnel, and others as appropriate for your school's IPM plan. The pest manager will review this document at the beginning of each visit and respond appropriately.

Integrated Pest Management Cafeteria Inspection Checklist

PAGES 18–19

The pest manager (or other personnel if appropriate) can use this form to ensure that the cafeteria receives a thorough inspection.

Intent to Apply Pesticides

PAGE 20

It is important to make teachers and staff aware of any necessary pesticide applications. This form should be completed by the pest manager and submitted to the IPM coordinator so that teachers and staff can be informed about upcoming pesticide applications in advance.

Please photocopy and provide these forms to appropriate personnel or adapt them to fit the specific needs of your institution.

Integrated Pest Management Pest Sighting Log

(This form may be copied as needed.)

FACILITY: _____

To Be Filled Out By School Official			To Be Filled Out By Pest Manager		
Location of Sighting Bldg. # / Specific Location	Type of Pest(s) Sighted	Date	Action Taken	Technician Name	Date

Integrated Pest Management—Cafeteria Inspection Checklist

(This form may be copied as needed.)

SCHOOL NAME: _____ **DATE/TIME OF INSPECTION:** _____ **INSPECTOR:** _____

Condition	Satisfactory	Unsatisfactory	Comments for Facilities/Maintenance
Building Exterior			
1. Garbage storage area			
2. Garbage handling system			
3. Perimeter walls			
4. Perimeter windows/openings			
5. Roof areas			
6. Parking lot and/or drainage areas			
7. Weeds and surrounding landscape			
8. Rodent-proofing			
9. Other			
Building Interior			
1. Walls			
2. Floors			
3. Ceilings			
4. Floor drains			
5. Lighting			
6. Ventilation/air handling equip.			
7. Other			
Food Storage			
1. Dry food storage area			
2. Damaged/spoiled dry food			
3. Empty container storage			
4. Refrigerated areas			
5. Overall sanitation			
6. Other			

(continued on next page)

IPM—Cafeteria Inspection Checklist *(continued)*

Condition	Satisfactory	Unsatisfactory	Comments for Facilities/Maintenance
Food Preparation/Distribution Areas			
1. Counter and surface areas			
2. Food serving lines			
3. Spaces around appliances/equipment			
4. Other			
Other Kitchen Areas			
1. Dishwashing areas			
2. Garbage/trash areas			
3. Tray return area			
4. Storage area for pots/pans/plates			
5. Other			
Utility Areas and Bathroom			
1. Sinks and toilets			
2. Custodian's closet/work area			
3. Other			
Lunchroom area			
1. Tables/chairs			
2. Office areas			
3. Vending machine area			
4. Other			

Recommendation to cafeteria employees to aid in pest prevention: _____

_____

This report reviewed by _____ _____
(NAME) (TITLE)

This report reviewed on _____
(DATE)

Action taken: _____

Intent to Apply Pesticides

(This form may be copied as needed.)

Date: _____

Facility: _____

Specific location in/near facility: _____

_____

Type of pesticide (circle): Insecticide Rodenticide Herbicide

Other: _____

Name of chemical and manufacturer: _____ EPA # _____

Day/date of pesticide application: _____ Time of day: _____

Length of time to stay off/out of treated area: _____

Name of certified applicator: _____

COMPLETED FORM SHOULD BE SENT TO IPM COORDINATOR PRIOR TO TREATMENT

Intent to Apply Pesticides

(This form may be copied as needed.)

Date: _____

Facility: _____

Specific location in/near facility: _____

_____

Type of pesticide (circle): Insecticide Rodenticide Herbicide

Other: _____

Name of chemical and manufacturer: _____ EPA # _____

Day/date of pesticide application: _____ Time of day: _____

Length of time to stay off/out of treated area: _____

Name of certified applicator: _____

COMPLETED FORM SHOULD BE SENT TO IPM COORDINATOR PRIOR TO TREATMENT

Technical Information for Pennsylvania Schools—Pests

Pests are any living organisms that negatively affect humans and their property. Pest organisms may include weeds, fungi, bacteria, insects, rodents, and other organisms. In school facilities, the most common pests in buildings are insects and rodents. In exterior areas such as ornamental plantings, sports fields, and lawns, pests may include weeds, plant diseases, and insects, among others.

A list of many of the insect, spider, and rodent pests sometimes found in and around Pennsylvania schools appears below. Not all pests found in and around schools have been included on this list, nor are all pests on the list necessarily found in any given school. In addition, not all pests on the list are included in this manual. Those described in this manual have a page number after their heading. The others are listed here to narrow down the search for further information concerning pest species.

Other groups of pests that are not listed but occasionally invade schools are parasitic bird mites, bedbugs, ground beetles, and moths attracted to lights. The list also does not include potential pests like pigeons, starlings, sparrows, Canada geese, chipmunks, groundhogs, or deer.

Information about pests not included in this manual can be obtained from Penn State Cooperative Extension agents, pest management professionals, Web sites, or other references found in the literature citations and additional references listed at the end of this manual.

IPM strategies depend on proper identification of the pest you wish to manage. Misidentification leads to improper treatment strategies and wastes time and money. Even pests of similar types often have different habits, habitats, food requirements, and management strategies.

Penn State Cooperative Extension agents and other IPM professionals can provide help with identification and information needed to properly manage various pests. They also can make recommendations about treatments, which may include contracting with a pest management professional.

Pests Found In and Around Schools

Ants—Hymenoptera (page 24)	
Carpenter ant	*Camponotus* spp.
Larger yellow ant	*Acanthomyops interjectus*
Odorous house ant	*Tapinoma sessile*
Pavement ant	*Tetramorium caespitum*
Pharaoh ant	*Monomorium pharaonis*
Thief ant	*Solenopsis molesta*
Bees, Hornets, and Wasps—Hymenoptera (page 99)	
Bees	*Apis* spp., *Bombus* spp.
Hornets	*Dolichovespula maculata*
Paper wasps	*Polistes* spp.
Solitary wasps	Various species
Yellowjackets	*Vespula* spp.

(continued on next page)

Cockroaches—Blattaria (page 34)

American cockroach	*Periplaneta americana*
Brownbanded cockroach	*Supella longipalpa*
Cuban cockroach	*Panchlora nivea**
German cockroach	*Blattella germanica*
Oriental cockroach	*Blatta orientalis*
Pennsylvania wood cockroach	*Parcoblatta pensylvanica*
Surinam cockroach	*Pycnoscelus surinamensis**

* Found in greenhouses and mall plantings in Pennsylvania.

Fleas—Siphonaptera (page 45)

Cat flea	*Ctenocephalides felis*
Human flea	*Pulex irritans*

Flies—Diptera (page 50)

Blue bottle fly	*Cynomyopsis cadaverina*, *Calliphora* spp.
Cluster fly	*Pollenia rudis*
Fruit fly	*Drosophila* spp.
Green bottle fly	*Phaenicia sericata*
House fly	*Musca domestica*
Moth fly (drain fly)	*Psychoda* spp.
Phorid fly (drain fly)	*Megaselia scalaris*

Landscape Pests (page 77)

Borers	
Larvae of moths or beetles	Lepidoptera, Coleoptera
Foliage-feeding insects	
Beetles	Coleoptera
Caterpillars	Lepidoptera
Leaf miners	
Larvae of flies, beetles, or moths	Diptera, Coleoptera, Lepidoptera
Plant-sucking pests	
Aphids	Homoptera: Aphidae
Lace bugs	Hemiptera: Tingidae
Mealybugs	Homoptera: Pseudococcidae
Scales	Homoptera: Coccidae, Diaspididae
Spider mites	Acarina: Tetranychidae
Thrips	Thysanoptera: Thripidae
Whiteflies	Homoptera: Aleyrodidae

Lawn Pests (page 63)

Billbugs	*Sphenophorus* spp.
Chiggers	Acari: Trombiculidae
Hairy Chinch bugs	*Blissus leucopterus hirtus*
Snails	Pulmonata: Helicidae
Sod webworms	Crambinae spp.
Spittlebugs	Homoptera: Cercopidae
White grubs	Coleoptera: Scarabaeidae

Lice—Phthiraptera (page 58)	
Body louse	*Pediculus humanus corporis*
Crab louse	*Phthirus pubis*
Head louse	*Pediculus humanus capitis*
Miscellaneous Pests (pages 29 and 71)	
Booklice	*Liposcelis* spp.
Clothes moth	*Tinea pellionella, Tineola bisselliella*
Firebrat	*Thermobia domestica*
House Centipede	*Scutigera coleoptrata*
Silverfish	*Lepisma saccharina, Ctenolepisma* spp.
Stored products pests	Coleoptera, Lepidoptera
Occasional Invaders	
Boxelder bug	*Boisea trivittatis*
Cluster fly	*Pollenia rudis*
Earwigs	Dermaptera
Elm leaf beetle	*Pyrrhalta luteola*
Millipedes	Arthropoda: Diplopoda
Multicolored Asian lady beetle	*Harmonia axyridis*
Sowbugs	Crustacea: Isopoda
Western conifer seed bug	*Leptoglossus occidentalis*
Rodents (page 60)	
Black rat	*Rattus rattus*
House mouse	*Mus musculus*
Norway rat	*Rattus norvegicus*
Spiders (page 73)	
Black widow spider	*Latrodectus mactans*
Brown recluse spider	*Loxosceles* spp.
Jumping spider	*Phidippus audax*
Wolf spider	Lycosidae
Yellow sac spider	*Chiracanthium* spp.
Termites (page 84)	
Eastern subterranean termite	*Reticulitermes flavipes* *R. hageni* *R. virginicus*

IPM for Ants in Schools

INTRODUCTION

Ants become pests when they invade buildings in search of food or shelter. It is often very difficult and laborious to eliminate most ants from their outside habitat, so management efforts should aim at preventing ants from invading structures. Unfortunately, prevention is not always successful and management actions must be implemented.

Although ants often are regarded as pestiferous, they are beneficial in several ways. Ants are predators of numerous pest insects, including fly larvae and termites. By aerating soil and recycling dead animal and vegetable material, they aid in the formation of topsoil. Ants also are responsible for pollinating plants in some areas. Ants provide a great service to the environment, and management efforts that prevent or suppress ants are preferred over practices that aim to eliminate ants.

IDENTIFICATION AND BIOLOGY

Ants are social insects. They live in colonies whose members are divided into three castes: workers, queens, and males. The workers enlarge and repair the nest, forage for food, care for the young and the queen, and defend the colony. The queen lays eggs, and the males serve only to mate with the queens.

Ants pass through four stages of development: egg, larva, pupa, and adult. After mating with males, queens lay eggs that hatch into blind, legless larvae. The larvae are fed and cared for by worker ants. At the end of the larval stage they turn into pupae, which do not feed. After a short period of time, adult ants emerge from their pupal cases and become worker ants.

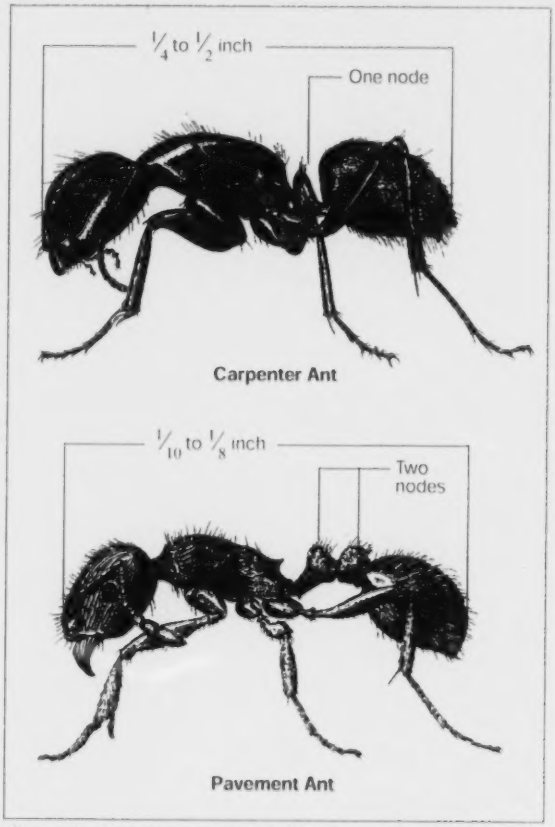
The first step in managing pest ants is proper identification, since many types of ants may invade a structure. It is critical to identify the type of ant you want to management, because most ants differ in their habits and food preferences. See Table 1, "Common House-Invading Ant Species."

DAMAGE

Many species of ants, such as pavement ants, are particularly prone to infesting food. Inside buildings, these ants are merely a nuisance, since they almost never bite. However, ants walk over many different kinds of surfaces and sometimes feed on dead animals and insects, so it is possible that they can carry disease-causing organisms to human food. Assume that ant-infested food has been exposed to organisms that can cause spoilage, and throw it away.

Carpenter ants may cause some structural damage as they excavate moist, rotting wood and other soft materials (such as foam insulation board) to make satellite nests.

FIGURE 1. Carpenter and Pavement Ants



(Illustrations from The Ohio State University fact sheet *Ants in and Around the Home*, HYG 2064-96)

Most of the information for this chapter was modified from:
IPM for Schools: A How-to Manual. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.
Bode, W. M. and S. B. Jacobs. *Carpenter ants*. The Pennsylvania State University. Entomology-HP-1. 1995.
Jacobs, S. B. *Pavement ant*. The Pennsylvania State University. Entomology-NP-11. 2000.

TABLE 1.

Common House-Invading Ant Species

Species	# of nodes in pedicel	Description of workers	Habits
Pharaoh Ant *Monomorium pharaonis*	2	Small, around $\frac{1}{16}$ to $\frac{1}{12}$ inch (1.5–2.0 mm) long, yellowish to red, often confused with thief ant, but has 3 segments in the club-like structure at the end of the antennae.	Nests in any secluded spot; prefers temperatures between 80° and 86°F; frequent house invader, often found around kitchen and bathroom faucets, where it obtains water; feeds on sweets but prefers fatty foods; eats dead insects.
Thief Ant *Solenopsis molesta*	2	Very small, around $\frac{1}{16}$ inch (1.3–1.8 mm) long; yellowish; often confused with Pharaoh ant, but has 2 segments in the club-like structure at the end of the antennae.	Often lives in association with other ants as predator of brood; omnivorous but prefers grease or high-protein foods over sweets; frequent house invader; may nest indoors in cracks and cupboards.
Carpenter Ant *Camponotus pensylvanicus*	1	Large, $\frac{1}{4}$ to $\frac{1}{2}$ inch (6–12 mm) long; shiny dark brown to black; evenly rounded thorax when viewed from the side.	Nests in logs, stumps, hollow trees; may nest in moist, rotting wood and foam plastic insulation board to make satellite nests; omnivorous; common house invader.
Larger Yellow Ant *Acanthomyops interjectus*	1	Around $\frac{1}{8}$ to $\frac{1}{6}$ inch (4–4.5 mm) long; pale yellowish brown; when crushed, smells like citronella.	Lives in soil next to foundation, under basement floor, concrete voids, or rotting wood; feeds on honeydew of subterranean aphids and mealybugs.
Pavement Ant *Tetramorium caespitum*	2	Around $\frac{1}{16}$ to $\frac{1}{8}$ inch (2.5–4 mm) long; light to dark brown or blackish; head and thorax furrowed by parallel lines.	Nests under stones and edges of pavement, in winter will nest in houses in crevices adjacent to a heat source; slow-moving; tends aphids for their honeydew; feeds on seeds, insect remains, and greasy materials.
Odorous House Ant *Tapinoma sessile*	1	Around $\frac{1}{10}$ to $\frac{1}{8}$ inch (2.4–3.25 mm) long; brownish to black; emits foul odor when crushed.	Frequent house invader; nests in a wide variety of places outdoors and inside; multiple queens; colonies are localized; prefers honeydew from aphids, scales, etc., but is an opportunistic species and will feed on other sweets, protein, and grease.

(Chart adapted for Pennsylvania schools by J. Kenneth Long, Jr., PA IPM program assistant, October 1999, from the University of Florida School IPM Web site article Common House-Invading Ant Species at **http://schoolipm.ifas.ufl.edu/tp6b.htm**)

DETECTION AND MONITORING

Visual inspection is the most useful monitoring technique for detecting ants, and can be very useful in preventing a developing infestation. A thorough inspection and prevention program is required to locate the ant source.

- Make a map of the school on which you can note problem areas and areas needing repair.
- A bright flashlight, kneepads, and a mirror are helpful.
- Carry a caulking gun to seal holes and cracks during inspection to prevent ants from gaining entry to the structure.
- Keep accurate records during the monitoring program to help formulate an IPM plan and evaluate its effectiveness.
- Ants are most likely to be indoor pests in kitchens and food preparation areas.
- An ant infestation may indicate that there has been a change in the methods of storing food or food waste that allows increased food sources for ants. Note how food and food wastes are stored in the area, and whether refuse containers are emptied and cleaned regularly. Inspect recycling bins to ensure that recyclables have been cleaned before being placed in bins.
- Talk with kitchen staff and custodians to learn more about the problem from their perspective.
- Ants can be attracted to snacks kept in classrooms or teachers' lounges and to sweet drinks accidentally spilled on the floor.
- Glue boards or sticky traps placed in areas ants are likely to be found can be useful in monitoring.
- Carpenter ants are attracted to moist areas. Check any areas where there might be a water leak, or moist or rotting wood (including firewood, logs, or stumps outside).

MANAGEMENT OPTIONS

Habitat Modification

The environment should be modified to reduce ant entryways and access to food. With quality materials and careful work, the alteration will be permanent and will make a long-term impact on the number of ant invasions.

Caulking

- Caulk all potential entryways with a silicone caulking compound.
- Use mildew-resistant caulk in moist areas.
- It is not necessary or practical to seal all cracks, but begin with the access point that the current trail of ants is using.
- Always carry caulk when making inspections, and seal as many cracks as time allows, especially those around baseboards, cupboards, pipes, sinks, toilets, and electrical outlets. Silicone caulks are flexible, easy to apply, and long-lasting.
- Use weatherstrip around doors and windows where ants may enter.
- Repair any water leaks and replace moist or rotting wood as needed.

Sanitation

Sanitation eliminates food for ants. Thorough daily cleaning of school kitchens and food preparation areas is essential.

- Sweep and mop floors.
- Drain all sinks and remove any food debris.
- If children regularly receive snacks in classrooms, these floors should be vacuumed and/or mopped daily.
- Periodically give all food preparation areas a complete cleaning, focusing on areas where grease and food debris accumulate. These include drains, vents, deep fat fryers, ovens, stoves, and hard-to-reach areas behind or between appliances. Thoroughly clean these areas with a powerful vacuum.
- At the end of each day, remove all garbage that contains food from the building.
- Use soapy water to wash any bottles, cans, wrappings, and other items that have food residues before storing them for recycling.
- If dishes cannot be washed right away, it is very important that they at least be rinsed to remove all food debris.
- Place garbage in sealed plastic bags, then place the bags into a rodent-proof dumpster or other storage receptacle.
- Keep garbage cans and dumpsters as clean as possible to deny food to ants, as well as roaches, flies, mice, and rats.

Proper Food Storage

- Food not kept in the refrigerator should be kept in containers that close tightly. Cardboard boxes are not ant- or roach-proof.
- Keep particularly attractive substances, like sugar and honey, in a refrigerator.
- Although refrigerator storage is usually safe, ants sometimes get into refrigerators even when the seals appear intact. When this occurs, a light, temporary coating of petroleum jelly on the edge of the refrigerator seal will exclude the ants.
- Screw-top jars are ant-proof only if the lid has a rubber seal, because some ants can follow the spiral ridges to get into the jar.
- Glass containers with rubber gaskets or plastic containers with tight-fitting, snap-top lids are also ant-proof.
- Upon delivery, transfer packaged food into plastic or glass containers. To prevent roach problems, do not bring shipping boxes into the food preparation area. Instead, boxes should be broken down and stored away from the kitchen in a cool area until removed for recycling.
- Advise students and teachers not to leave unsealed food items in their desks or lockers.
- Any food kept in offices or classrooms should be stored in ant-proof containers.
- Storage shelves should be far enough off the floor to facilitate cleaning and to reduce the possibility of access by insects or rodents. No supplies should be stored on the floor.

Physical Controls

At times when only a few ants are noticed foraging in an area, squashing or crushing the ants may be effective. However, foragers represent about 10 percent of an ant population, so further management efforts may be needed.

Vacuuming

- Use a strong vacuum to vacuum up trails of ants effortlessly and quickly.
- Vacuum up a tablespoon of cornstarch to kill ants in the vacuum bag.
- Carpenter ant colonies living under insulation may be removed by vacuuming.

Detergent Barrier
Temporary "moats" of detergent and water may be useful during heavy ant invasions.

- Containers of food or food waste which must remain open during working hours can be placed in large, shallow pans filled with water mixed with a small amount of detergent.
- Use this technique to protect potted plants from ants that may be attracted to nectar produced by the plant or to honeydew produced by plant-feeding insects. Elevate the pot above the detergent-and-water mixture by placing it on an overturned saucer. Make sure the plant is not in contact with anything that ants could use as a bridge. This will not manage an auxiliary colony which may already be established in the pot.

Chemical Control

At times, nonchemical methods alone prove insufficient to solve the problem. Integrating a pesticide into your management program may be necessary to gain control of the ant problem.

Pesticides must be used in accordance with their EPA-approved label directions. Applicators should always wear protective equipment during applications. All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Do not apply these materials in common access areas when occupied, and never apply them where they might wash into a drain or sewer unless otherwise labeled. **Pennsylvania law allows pesticide applications in schools only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator. The law also mandates a 7-hour reentry period for common access areas whenever pesticides are applied.**

When treating for ants, use only crack and crevice treatments.

Detergent and Water
When ants invade a classroom or food preparation area, the best emergency treatment is a mixture of detergent and water in a spray bottle. This mixture will quickly immobilize the ants, which can then be wiped up with a sponge and washed down the drain. Each classroom, cafeteria, and food preparation area should be equipped with a spray bottle so teachers and staff can safely deal with emergencies.

Boric Acid
Boric acid is one of the most valuable chemical tools in an integrated ant management program. It is formulated as a dust, gel bait, and aerosol.

If kept dry, boric acid dust remains effective for long periods of time. Boric acid gel baits are very effective in controlling many species of ants.

- When applying boric acid dust, wear a dust mask to avoid breathing the material.
- Use a bulb duster to apply a light dusting in cracks and crevices. Boric acid should never be applied to large open areas.
- Boric acid is approved for crack and crevice treatment in kitchen and food preparation areas.
- Boric acid can be dusted into wall voids and spaces behind and under cabinets.

Diatomaceous Earth and Silica Aerogel
These are insecticidal dusts that can be used for ant management. Diatomaceous earth is made from fossilized diatoms, and silica gel is produced from sand. Both kill insects by desiccation: they abrade the wax and oil on the insect's outer covering, leading to dehydration and death. Although these materials are not directly poisonous to humans, the fine dust travels freely through the air and can be irritating to the eyes and lungs. Use a dust mask and goggles during application.

Diatomaceous earth and silica aerogel are especially useful in wall voids and similar closed spaces. These dusts can be blown into such spaces during construction and remodeling. In finished buildings, they can be applied by drilling tiny holes in the walls. These dusts also are useful in crack and crevice treatments.

Granular Applications
Granular applications, if used appropriately, can act as a temporary barrier and prevent ants from entering the school building. The material should be directed along the foundation 2 or 3 feet out onto the soil. Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels.

Ant Baits

Baits greatly reduce the amount of pesticide that must be used to kill ants. Foraging ants take the bait back to the nest to feed to other members of the colony, resulting in colony death. Fast-acting baits kill foraging workers quickly, but are less effective than those that are slow-acting and can be taken back to the nest for consumption. Even if the queen is not killed, baits will usually stop an ant invasion. If a colony has been starved by effective sanitation measures, baits will be more readily accepted.

Baits should be placed out of sight and reach of children.

Some ants are very susceptible to baits, some are less so. There are many reasons for these differences, only some of which we understand. If you are having difficulty in managing ants with a bait, the following points may be helpful:

- Correct identification of the species of ant is essential since each species differs in its food preferences. Some baits use a sweet attractant, while others use a protein or oily attractant. The attractant used must be preferred by the type of ant you wish to manage. If you cannot determine the type of attractant by looking at the label, call the manufacturer for more information. You also should ask if the company has data to support the efficacy of their product against the ant species you are dealing with.
- After setting out bait, observe to see if the target ant is taking the bait.
- Ant colonies have changing nutritional requirements that can pose problems in baiting. A colony that accepted a protein bait one week may be more interested in a sugar bait the next.
- The nesting and foraging environment can also affect bait acceptance. Ants nesting and foraging in dry areas will be more interested in baits with a high water content than will ants nesting in moist environments.
- When there are several competing ant species in one area, nontarget ants may accept your bait more readily than the pest ant and, in some cases, prevent the pest ant from getting to the bait.
- Do not spray pesticides when using baits. Bait stations contaminated with pesticide are repellent to ants, and sprays disperse the ant infestation, making it more difficult to place baits effectively.
- Place bait stations along foraging trails, but do not disturb ant trails between the nest and the bait. Killing the ants or disturbing the trails prevents the ants from taking the bait back to the colony to kill nest mates.
- Do not apply bait until an ant problem is noticed. If you use baits preventively, you may attract ants into the building.
- Some baits come packaged in plastic disc "bait stations" that come with double-sided tape so they can be attached to various surfaces out of view. It is important to remove bait stations once management is attained, because the stations may serve as harborage for cockroaches. Some baits are formulated as granules or gels that can be injected into wall voids through small holes. Gel baits also can be placed near ant trails in inconspicuous places where they will not be disturbed.

IPM for Clothes Moths and Carpet Beetles in Schools

INTRODUCTION

The insects discussed in this chapter, clothes moths and carpet beetles, are sometimes referred to as fabric pests. They feed on wool, feathers, fur, hair, leather, lint, dust, paper, and occasionally cotton, linen, silk, and synthetic fibers. Most damage is done to articles left undisturbed for a long time.

IDENTIFICATION AND BIOLOGY

Clothes Moths

The most common fabric-attacking moths are the webbing and the casemaking clothes moths. Both the webbing clothes moth (*Tineola bisselliella*) and the casemaking moth (*Tinea pellionella*) are common in Pennsylvania. The adults of both species are about ¼ inch long and have a wingspan of about ½ inch. The webbing clothes moth is golden buff or yellowish gray with a satiny sheen, and the hairs on its head are upright and reddish. The casemaking clothes moth is similar in size and shape, but has a browner hue and three indistinct dark spots (which may be worn off with age) on the wings, with lighter-colored hairs on the head.

Adult moths of both species avoid light and attempt to hide when disturbed, which helps distinguish these moths from other small moths found in buildings (see Table 2). Clothes moths are occasionally seen flying in subdued light. Males fly more often than females, but both may fly considerable distances and can move from building to building in favorable weather. Adults can be seen flying at any time of year, but they are more common during the summer months.

The life cycles of the two moths are similar. Adult females lay an average of 40 to 50 eggs. Incubation takes from 4 days to 3 weeks, or sometimes longer. If conditions are good—meaning abundant food, temperatures around 75°F, and at least 75 percent relative humidity—a new generation can be produced in a month. It takes over a year when conditions are less favorable, and periods up to four years have been recorded in the laboratory. The larval and pupal stages combined may take from 45 days to more than a year to complete. At ordinary household temperatures, adult moths live from 2 to 4 weeks. The adults do not feed on fabrics.

TABLE 2.

Distinguishing Between Common Clothes Moths and Grain Moths

Species	Distinguishing Characteristics
Webbing clothes moth *Tineola bisselliella*	Wingspan ½ inch, body length ¼ inch Wings golden yellow without spots, hind wings rounded Body covered with shiny golden scales Tuft of reddish hairs on head
Casemaking clothes moth *Tinea pellionella*	Slightly smaller than webbing clothes moth Whitish head Wings black on first third, lower two-thirds creamy white, may have some spots on white area Larvae always in case Adults fly in dark areas
Mediterranean flour moth *Anagasta kuehniella*	Wingspan ⅝ inch Hind wings dirty white, forewings pale gray with transverse black wavy bars Forebody distinctly raised at rest
Indianmeal moth *Plodia interpunctella*	Wingspan ½ inch, ⅜ inch at rest Wings light gray at base with reddish-brown or bronze on outer half Favors dried fruit but will feed on many other stored products
Angoumois grain moth *Sitotroga cerealella*	Wingspan ½ inch Pale yellow forewings and gray pointed hind wings

Adapted from Olkowski, et al., 1991

Most of the information for this chapter was modified from:
IPM for Schools: A How-to Manual. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.
Clothes Moths. The Ohio State University Extension Fact Sheet. HYG-2107-97.
Jacobs, S. B. *Clothes moths*. The Pennsylvania State University. Entomology-HP-17. 2000.

In heated buildings, female webbing clothes moths can mate and lay eggs any time during the year. The case-making clothes moth generally produces one generation each year.

The larvae of both moths are also similar (pearly-white, naked bodies and dark heads), but the casemaking moth larva spins a characteristic silken tube under which it feeds. These tubes can include parts of the fabric. Larvae of both species range from ¼ to ½ inch long when fully grown. Their fecal matter is often the same color as the material they consume.

Carpet and Hide Beetles

Adult beetles are small and have short, clubbed antennae, but are otherwise varied in appearance (see Table 3). Their bodies are covered with small scales or hairs, which are visible with a magnifying glass. Larvae are brownish, ⅛ to ½ inch long, and characteristically hairy or bristly.

As with clothes moths, the larval stage is the most damaging. Females lay eggs throughout the year and the eggs hatch in less than two weeks. The larvae feed for varying periods, depending upon the species and environmental conditions. When ready to pupate, the larvae may burrow farther into the food or wander and burrow elsewhere. They also may pupate within their last larval skin or burrow into wood if no other location is found. Beetle larvae do not construct webs, but their shed skins and fecal pellets make it obvious where they have been feeding. The cast skins look so much like live larvae that under casual inspection they may seem to indicate a far larger infestation than is actually present.

Some adult carpet beetle species feed on pollen and nectar; they may be introduced into a school on cut flowers. They are sometimes mistaken for lady beetles, because some species are similarly round in shape.

DAMAGE

Clothes Moths

Adult clothes moths do not feed; only their larvae cause damage. Clothes moth larvae feed on pollen, hair, feathers, wool, fur, dead insects, and dried animal remains. Feeding holes are scattered over the material and are usually small. Clothing, carpets, furs, blankets, upholstery, piano felts, and myriad other items are subject to their attack. They will also feed on wool mixed with synthetic fibers. Only the wool is digested; the other fibers pass through the insect's gut. Clothes moths are attracted to stains on fabrics from food and human sweat and urine. Clothes moths most often damage stored goods, because the larvae are fragile and cannot survive in clothing worn regularly.

DAMAGE

Carpet and Hide Beetles

Carpet beetle holes are usually concentrated in a few areas and can be quite large, in contrast to clothes moth holes. As a group, these beetles cause far more damage than clothes moths, since the range of substances they consume is much wider. Carpet beetles damage materials made from wool, such as sweaters, uniforms, felt, and wool yarn. They also can destroy insect collections, furniture, and carpets. Hide beetles feed on animal carcasses and hides, and also damage furnishings, carpets, and fabrics. Some species also infest stored, dried foods such as cereal (see Table 3).

TABLE 3.

Important Carpet or Hide Beetles and Their Food Sources

Species	Description of Adults	Food Source
Furniture carpet beetle *Anthrenus flavipes*	1/16 to 1/8 inch long Definite cleft at rear Mottled with black, white, and yellow scales	Wool, hair, fur, feathers, bristles, horn, silk, animal excreta, stained linen, cotton, rayon, jute, softwood, leather, bags, dead mice, dead insects, dried cheese, old grain, casein, dried blood, and glue of book bindings
Common carpet beetle *Anthrenus scrophulariae*	1/8 inch long Blackish with varied pattern of white and orange scales on back Scalloped band of orange-red scales down middle of back	Carpets, fabrics, woolens, feathers, leather, furs, hairbrush bristles, silks, mounted museum specimens; adults found on blossoms; can enter building on cut flowers
Varied carpet beetle *Anthrenus verbasci*	1/8 inch long Mottled with white, brownish, and yellowish scales	Nests of bees, wasps, and spiders, carpets, woolen goods, skins, furs, stuffed animals, leather book bindings, feathers, horns, hair, silk, corn, red pepper, dead insects in collections
Black carpet beetle *Attagenus unicolor*	1/16 to 1/8 inch long, oval Shiny black and dark brown with brownish legs	Feathers, dead birds, birds' nests, seeds, grains, cereals, woolen rugs, clothing, carpeting, felts, furs, skins, yarn, velvet, silk, upholstered furniture, milk powder, books, pet food, spilled flours, pollen
Black larder beetle *Dermestes ater*	3/16 to 5/16 inch long Black with yellowish gray hair Black rounded and hook-shaped spots on underside of abdomen	Mouse carcasses in walls of building; partially burned food and other kitchen wastes in incinerators; pet food
Larder beetle *Dermestes lardarius*	3/16 to 5/16 inch long Dark brown with pale grayish yellow hair Yellow band at base of wing covers with about six black spots	Stored ham, bacon, meats, cheese, dried museum specimens, dried fish, dog biscuits; can tunnel slightly in wood; reported to attack newly hatched chickens and ducklings
Hide beetle, leather beetle *Dermestes maculatus*	1/4 to 5/16 inch long Black with white hairs on sides and undersides Apex of each wing cover comes to a fine point	Prefers hides and skins; used to clean carcasses; known to survive on smoked meat and dried cheese; larvae can tunnel short distances into wood
Warehouse beetle *Trogoderma variable*	1/8 inch long Brownish black	Prefers barley, wheat, animal feeds, grains, pollen; found in seeds, dead animals, cereals, candy, cocoa, cookies, corn, corn meal, dog food, fish meal, flour, dead insects, milk powder, nut meats, dried peas, potato chips, noodles, dried spices

Adapted from Mallis, 1992, and Olkowski, et al., 1991.

DETECTION AND MONITORING

Look for holes in fabric, larvae, moth cocoons, cast skins of beetle larvae, or insect excreta in stored materials, or for small moths fluttering about in dimly lit areas. The fluttering flight itself is quite distinctive, and may be enough to distinguish clothes moths from food-infesting moths, which have a steadier flight.

Unlike moth larvae, carpet beetle larvae may be found wandering far from their food, particularly to pupate. They will sometimes burrow into wood, Styrofoam, and other objects in order to pupate. Also, unlike clothes moths, adult carpet beetles do not shun light and may be found crawling on windows. This is often the first place they are noticed.

These beetles and moths are easy to catch: cover the insect with a jar and slowly slide a card under the open end. Seal the jar and place it in the freezer overnight. The dead insect can be examined with a magnifying glass or taken to your Penn State Cooperative Extension county agent or another professional for identification.

An inspection should include the following locations:

- around carpets or furniture covered or filled with susceptible materials; infestations may be under the slipcovers, where it is dark and quiet, or in the pads under the carpet
- around accumulations of lint and other organic debris, particularly under and behind furniture that is rarely moved; in wall and floor cracks; in cracks behind filing cabinets, shelves, or other built-in items that may not be flush with the wall; behind baseboards, moldings and window trim; and in cold air and heater ducts
- around stored animal specimens, feathers, garments, blankets, or other items made of susceptible materials

- around bags or boxes of dried milk, fish or meat meal, dog food, and similar products (note that carpet beetles can bore through cardboard and paper packaging)

If the infestation does not appear large enough to account for the number of pests found, or if cleaning up the infestation does not seem to diminish their number, then a further search should focus on less obvious sources:

- bird, wasp, bee, squirrel, or other animal nests on or very close to the walls of the building
- animal carcasses or trophies, insect collections, or leather or horn goods
- cut flowers, or blooming bushes near open, unscreened windows or doorways
- incompletely incinerated garbage

In some circumstances, sticky traps placed in areas where activity is suspected may be useful for monitoring. Hang them where you suspect there might be an infestation and check them daily. Sticky traps that contain an attractant called a "sex pheromone" are available for monitoring of the webbing clothes moth. A sex pheromone is a chemical signal that female moths give off to attract males.

MANAGEMENT OPTIONS

Physical Controls

Storage in Tight Containers

If clean materials are placed in tightly sealed containers, they will be safe from infestation. The problem with closets and similar storage areas is that they are almost impossible to seal effectively: the tiny, newly hatched larvae can crawl through any gap larger than 0.0004 inch.

Entomologist Roy Bry of the USDA Stored Product Insects Laboratory in Savannah, Georgia, suggests wrapping clean, susceptible materials in heavy brown paper and carefully sealing the package with heavy-duty tape. As long as the package is not punctured or torn, the contents should be safe from attack for years. Clean materials could also be stored in heavy-duty resealable plastic bags or heavy-duty plastic garbage bags (2.7 mils or thicker, or a double bag) sealed with tape (Bry et al., 1972).

All grains, cereals, and other similar susceptible substances should be stored in tight-fitting containers that deny beetles access. Containers can be placed in the freezer for a few days to help reduce the possibility of an infestation developing.

Cedar Products

Cedar chests have long been thought to protect against fabric pests, but it has been known for many years that although cedar oil can kill very young clothes moth larvae, the oil does not affect eggs, pupae, adults, or larger larvae, and that cedar lumber loses its oil in only a few years (Back and Rabek, 1923; Laudani and Clark, 1954; Laudani, 1957). Moreover, commercial repellents made from cedar, cedar oil, or herbs cannot be counted on to give adequate control to protect goods (Abbott and Billings, 1935).

Vacuuming

Accumulations of lint, human and animal hair, and other organic debris in cracks and crevices of floors, baseboards, closets, and shelves provide food for fabric pests. These areas should be cleaned thoroughly and regularly to prevent infestations. It is particularly important to clean under furniture that is rarely moved (desks, bookcases, cabinets); in closets where fabric items, furs, and feather-filled materials are stored; and inside and behind heaters, vents, and ducts.

Caulking

Caulking or otherwise repairing cracks and crevices where lint and hair can accumulate will reduce the number of fabric pests that are able to live in the environment. Areas of particular concern are the spaces inside cabinets where shelves do not meet the wall and similar spaces in drawers holding susceptible materials. These same habitats are likely to be inviting to cockroaches, which can also damage stored products.

Cleaning and Airing Fabrics, Carpets, and Furniture

Since many fabric pests are attracted to the food, beverage, perspiration, and urine stains in woolens and other materials, garments should be dry cleaned thoroughly before being stored. If materials cannot be stored in moth- and beetle-proof packages or containers, they should be shaken, brushed, and aired regularly. This will kill delicate moth larvae and cocoons. Vigorous brushing can remove moth and beetle eggs. Susceptible furniture and carpets that cannot be washed can be steam-cleaned.

Fabrics and other items badly damaged by beetles should be thrown away in sealed plastic bags or burned. If the item is salvageable, submerge it in hot soapy water (at least 120°F) for 2 to 4 hours to kill the larvae and eggs.

Exposure to Heat

Heat can be used to kill all stages of the clothes moth hiding in cracks and crevices of an infested closet or storage space. Remove all materials from the space and place a heater in the center of the floor. Turn the heater to its hottest setting and monitor the temperature with a thermometer that registers temperatures over 120°F. Keep the temperature at 130° to 140°F for 1 to 4 hours to kill the insects (Ebeling, 1975). Make sure there are no materials in the area that can be damaged by the sustained heating.

Exposure to Cold

Sudden changes in temperature from cold to warm can kill clothes moths. In the *Handbook of Pest Control*, Arnold Mallis (1982) suggests that "if articles infested with clothes moths were refrigerated at 18°F for several days, then suddenly exposed for a short time to 50°F, and then returned to 18°F, and finally held permanently at about 40°F, all moth life in them would be killed .... During the winter if furniture is placed outdoors at 0°F for several hours, it often results in good control." Smaller items should be bagged and moved in and out of bin-type freezers that are normally kept at 0°F. Infested items can be placed in tightly closed plastic bags in a freezer for 2 to 3 days, since few insects can withstand this temperature. After that, they can be moved for long-term storage to closets or chests at room temperature.

Removal of Animal Nests

Clothes moths and carpet beetles can sometimes move into buildings from the abandoned nests of birds, rodents, bats, bees, and wasps, as well as from the carcasses of dead animals. Remove nests in the eaves or close to the walls of the school. Problems with birds' nests usually occur after the nestlings have left. Nests should be removed before the cold weather sets in and the beetles begin searching for sheltered hibernation spots. Use traps instead of rodenticide to resolve problems with rats and mice. If rodents die in inaccessible places, their carcasses can become food sources for fabric pests and flies.

Chemical Controls

Crack and Crevice Treatments

In older wooden buildings, these pests may be found throughout the structure hiding in crevices that protect them from treatment. Mallis (1997) suggests using silica aerogel or diatomaceous earth as a dust in cracks and crevices and voids. An insect growth regulator (IGR) may be needed in some cases. **Pennsylvania law allows pesticide applications in schools only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator. The law also mandates a 7-hour reentry period for common access areas whenever pesticides are applied.**

IPM for Cockroaches in Schools

INTRODUCTION

Cockroaches are the most important pests within schools, homes, and restaurants. They consume human foods and contaminate them with saliva and excrement. They produce secretions that impart a characteristic fetid odor, and their shed skin contains allergens that can cause allergic reactions such as asthma and other bronchial problems in people inhabiting or visiting infested buildings.

IDENTIFICATION AND BIOLOGY

Except for size and markings, cockroaches are generally similar in appearance: all species are flattened, oval-shaped insects with long legs and antennae. Only four species are common pests in Pennsylvania. These are the German, brownbanded, American, and oriental cockroaches. The Pennsylvania wood cockroach is an occasional invader in wooded areas, but dies shortly after entering a building, and therefore is not considered a pest. Table 4 lists their important characteristics, while Figure 2 offers a pictorial key to common roach species. Two other species, the Cuban and Surinam cockroaches, have been found in greenhouses and malls in Pennsylvania. They have not been included in the key.

In general, cockroaches like to squeeze into warm cracks and crevices, but the places they inhabit differ from one species to another. German cockroaches prefer kitchens and lavatory areas, while brownbanded cockroaches are most often found in dryer classroom and office areas. American and oriental cockroaches are generally found where there is high moisture, such as in sewers, basements, and mulch. Pennsylvania wood cockroaches are usually found only in wooded areas. They occasionally invade rural schools. The Cuban and Surinam cockroaches have only been found in indoor plantings, where they may damage the plants.

The life cycle of the cockroach begins with the egg case, or ootheca. In German, Cuban, and Surinam cockroaches, the female transports the egg case around with her until the eggs are about to hatch. The brownbanded, American, and oriental cockroaches deposit the egg case in a sheltered place, and the Pennsylvania cockroach deposits the egg case in wooded areas (see Table 4). Cockroaches undergo a gradual metamorphosis during their life. An immature cockroach, or nymph, looks much like an adult, but is smaller and wingless. As a nymph grows, it sheds its skin (molts) a number of times. The time it takes a cockroach to become an adult is affected by temperature. Nymphal cockroaches develop more rapidly when it is warm.

Cockroaches eat carbohydrates, protein, and fat. They will discriminate among foods if given a choice, but when hungry they eat almost anything. Some products not normally considered food—starch-based paints, wallpaper paste, envelope glue, and bar soaps—contain carbohydrates, and therefore are food for cockroaches.

Cockroaches are generally active at night and remain hidden during daylight. Daylight sightings usually indicate a large population that has overrun available harborage or a recent emigrant cockroach seeking shelter.

Most of the information in this chapter was modified from *IPM for Schools: A How-to Manual*. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.

TABLE 4.

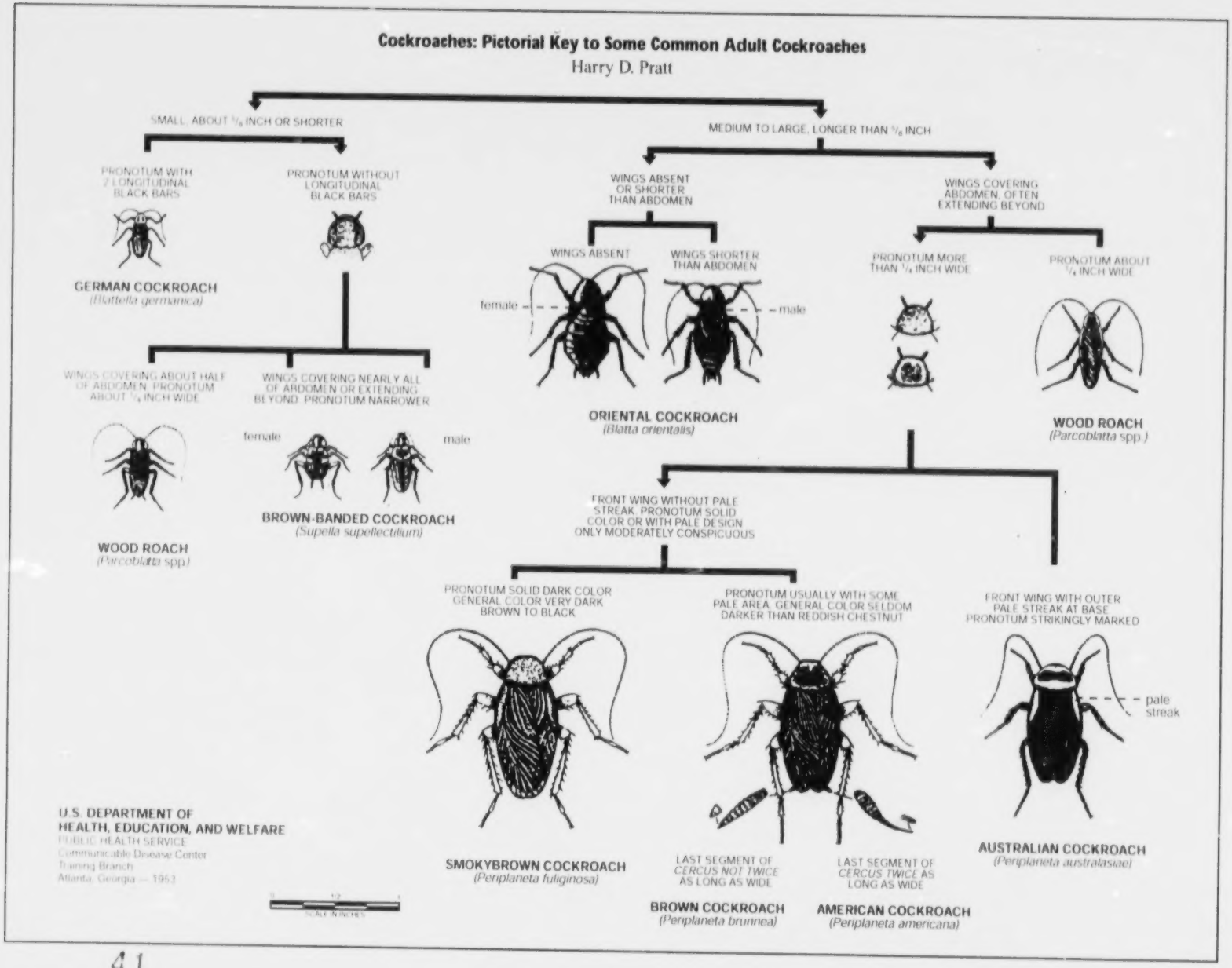
Characteristics of Common Cockroach Species

Common and scientific names	**German** *Blattella germanica*	**Brownbanded** *Supella longipalpa*	**American** *Periplaneta americana*	**Oriental** *Blatta orientalis*	**Pennsylvania wood** *Parcoblatta pensylvanica*	**Cuban** *Panchlora nivea*	**Surinam** *Pycnoscelus surinamensis*
Color and distinctive markings	Light brown with 2 black bars on the pronotum (platelike structure behind the head on the back)	Tan with faint v-shaped lighter bands on wings. Nymph has 2 distinct brown bands running crosswise on body.	Reddish brown throughout with a pale band on the edge of the pronotum.	Dark brown-black throughout. Adult male wings do not cover abdomen. Adult females are wingless.	Males chestnut brown, females black. Adult male wings cover the abdomen. Adult females have short, nonfunctional wings.	Uniformly pale green. Both sexes fully winged. Good fliers.	Pronotum uniformly dark, dark olive-green wings. Wings extend beyond abdomen. No known males exist (parthenogenic species).
Length of adult	½ to ⅝ inch	½ to ⅝ inch	1⅛ to 1¼ inch	1¼ inch	½ to 1 inch	¾ to 1 inch	¾ to 1 inch
Average # of eggs/egg case*	37	16	14	18	26	56	26
Life cycle from egg to adult	64–251 days	143–379 days	320–1,071 days	316–533 days	324–700 days	144–181 days	162–219 days
Reproduction characteristics	Female carries egg case until the nymphs hatch.	Egg case glued to ceilings, beneath furniture, or in closets, with glue egg cases on top of one another.	Egg case deposited on or near floor, usually close to food and concealed in debris. Needs high humidity to hatch.	Secures and conceals egg case in crevice, usually covers egg case with debris or sometimes with fecal pellets.	Egg case deposited only during summer, in wooded area.	Female carries egg case until the nymphs hatch.	Female carries egg case until the nymphs hatch.
Preferred habitat	Usually found in kitchen and restrooms. Prefers dark voids such as cracks and crevices not more than ⅛ inch wide, especially in warm moist areas, such as: • food preparation areas • undersides of tables, kitchen equipment, and service counters • kitchen cupboards • motor compartments of refrigerators • electrical fuse boxes • spaces under broken plaster or behind sinks	Favors cracks and crevices but prefers them in warm, dry areas throughout the building. Prefers high locations in heated buildings, but also can be found: • under furniture • in appliances that generate heat • on the undersides of counters that support appliances that generate heat • in ceiling light fixtures • in telephones • in desks • behind pictures and picture frames • in boxes • in piles of debris or stored material in closets	Usually found in basements or sewers. Prefers warm, moist areas, such as: • around furnaces or heating ducts • in steam pipe tunnels • in drainage manholes and grease traps • in sewers Can live outside during warm weather.	Found in areas with excessive moisture. Found in cooler areas of a building, such as: • basements • service ducts • crawl spaces Also can tolerate hot, dry locations such as: • radiators • ovens • hot water pipes • under floor coverings Can tolerate colder temperatures, and is capable of overwintering outdoors in colder regions of the United States.	Found in wooded areas. Males attracted to lights. Occasional invader in rural areas. Usually lives outside in hollow trees, under loose bark, and often in wood piles and in crevices in rural buildings. Nymphs can be active in subzero weather when exposed by pulling away bark from trees. Adults are present from May through early October.	Tropical insect. Found only in greenhouses and malls and indoor plantings. Attracted to lights.	Tropical insect. Found only in greenhouses and malls and indoor plantings. Burrows into loose soil. Active at night.

* The number actually hatched can be more.

(Modified for Pennsylvania schools from the University of Florida School IPM Web site article at: **http://schoolipm.ifas.ufl.edu/tp4t.htm**)

FIGURE 2.


Cockroaches: Pictorial Key to Some Common Adult Cockroaches
Harry D. Pratt
SMALL, ABOUT 5/8 INCH OR SHORTER
MEDIUM TO LARGE, LONGER THAN 5/8 INCH
PRONOTUM WITH 2 LONGITUDINAL BLACK BARS
PRONOTUM WITHOUT LONGITUDINAL BLACK BARS
GERMAN COCKROACH
(Blattella germanica)
WINGS ABSENT OR SHORTER THAN ABDOMEN
WINGS COVERING ABDOMEN, OFTEN EXTENDING BEYOND
WINGS ABSENT
WINGS SHORTER THAN ABDOMEN
female
male
ORIENTAL COCKROACH
(Blatta orientalis)
PRONOTUM MORE THAN 1/4 INCH WIDE
PRONOTUM ABOUT 1/4 INCH WIDE
WOOD ROACH
(Parcoblatta spp.)
WINGS COVERING ABOUT HALF OF ABDOMEN; PRONOTUM ABOUT 1/4 INCH WIDE
WINGS COVERING NEARLY ALL OF ABDOMEN OR EXTENDING BEYOND; PRONOTUM NARROWER
female
male
WOOD ROACH
(Parcoblatta spp.)
BROWN-BANDED COCKROACH
(Supella supellectilium)
FRONT WING WITHOUT PALE STREAK; PRONOTUM SOLID COLOR OR WITH PALE DESIGN ONLY MODERATELY CONSPICUOUS
PRONOTUM SOLID DARK COLOR GENERAL COLOR VERY DARK BROWN TO BLACK
PRONOTUM USUALLY WITH SOME PALE AREA; GENERAL COLOR SELDOM DARKER THAN REDDISH CHESTNUT
FRONT WING WITH OUTER PALE STREAK AT BASE; PRONOTUM STRIKINGLY MARKED
pale streak
SMOKYBROWN COCKROACH
(Periplaneta fuliginosa)
LAST SEGMENT OF CERCUS NOT TWICE AS LONG AS WIDE
LAST SEGMENT OF CERCUS TWICE AS LONG AS WIDE
BROWN COCKROACH
(Periplaneta brunnea)
AMERICAN COCKROACH
(Periplaneta americana)
AUSTRALIAN COCKROACH
(Periplaneta australasiae)
U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
Communicable Disease Center
Training Branch
Atlanta, Georgia — 1953
SCALE IN INCHES

41

42

DAMAGE

Cockroaches can carry and transmit many common pathogens that cause human and animal disease (Smith and Whitman, 1992). Consequently, their presence in kitchens and cafeterias should be deemed hazardous. However, the most important health issue associated with cockroaches is the production of allergens that can cause severe bronchial problems in sensitive individuals, most notably in children and the elderly.

DETECTION AND MONITORING

Efforts to manage cockroaches should begin with a thorough visual inspection and a continuous monitoring program. Once cockroaches have located a suitable harborage, they tend to concentrate in that site, which they leave only periodically to forage for food and water. Thus, the first step in any inspection is to locate potential cockroach harborage sites. This effort should be followed by monitoring of the area to locate specific cockroach infestations. This monitoring must continue after treatment to determine whether management efforts have satisfactorily reduced the cockroach population.

Establishing a Communication System

A successful monitoring program depends on clear and frequent communication with principals, teachers, custodians, and food-service personnel. These people have firsthand knowledge of pest sightings, sanitation problems, and other contributing factors, such as leaks, condensation problems, and harborage sites. With a small investment of time, school personnel can be trained to serve as additional sources of valuable information for the monitoring program.

Make sure personnel understand the following:

- the goals of the cockroach IPM program and the role monitoring plays
- their role in the IPM program (what they can do to help reduce the number of cockroaches and what kind of information they can provide)
- how they can best communicate with the pest management technicians (using log sheets to write down pest sightings and other information)

Visual Inspection

- Note any sanitation problems, such as food or grease spills, food or grease buildup behind or under kitchen equipment, or improper garbage disposal procedures.
- Note any leaks or condensation.
- Look for cockroach entry points, such as holes in walls or floors, around pipes where they may enter a wall, around electrical conduits, or in vents.
- Use the list of preferred habitats in Table 4, on page 35, to help you decide where to inspect, and refer to the list of tools used to inspect and monitor for cockroaches on the next page.
- Record on a "Pest Sighting Chart" locations where cockroaches have been found for repeat monitoring.

Where to Inspect

Define the specific areas on a map that are to be inspected for cockroaches. Inspect these areas from floor to ceiling in a systematic and logical fashion, making sure no potential harborage areas are overlooked. Be sure to inspect:

- in corners of rooms at floor and ceiling level
- under, behind, and around sinks, toilets, showers, bathtubs, drinking fountains, ice machines, dishwashers, beverage dispensers, and floor drains
- the engine compartments of refrigerators, beverage dispensers, toasters, air conditioners, and other equipment
- in and under stoves, hot plates, heaters, and near hot water pipes and radiators
- in and around stove vents, hoods, and grease traps
- between equipment and walls, and between adjacent appliances
- behind picture frames, mirrors, bulletin boards, and wall-mounted shelving
- in false ceilings, vents, light fixtures, ceiling-mounted fixtures, and railings
- in cupboards, linen closets, drawers, filing cabinets, lockers, and cluttered areas
- in and under cash registers, computers, telephones, electric clocks, televisions, switch boxes, and fuse boxes
- in and around check-out stands, vegetable bins, and meat counters
- cracks and crevices in walls and baseboards
- under edges and in corners of tables, desks, counters, and other furnishings and equipment
- indoor and outdoor trash containers, dumpsters, and recycling containers
- loading docks and storage areas where incoming food, supplies, equipment, and other potential sources of migrating cockroaches are received and stored

Tools Used to Inspect and Monitor for Cockroaches

Flashlight. Use a heavy-duty, corrosion-resistant model with a bright-colored body, shatterproof lens, and halogen or krypton bulb. A smaller halogen flashlight with a flexible neck is useful in tight, confined locations. Flashlight holders that can be attached to a belt are available.

Telescoping Mirror. Use a furnace inspector's or mechanic's metal mirror with a telescoping handle and rotating head. To illuminate areas inside equipment and fixtures, reflect the flashlight beam off the mirror.

Clipboard and Pen. Use the clipboard to carry monitoring forms, floor plans, and other documents during inspections.

Floor Plan Maps and Building Plans. Carry a floor plan with the major equipment and fixtures marked. In large buildings, construction drawings that show utility lines, heating/cooling ducts, shaft connections, pipe chases, and other features are very useful for locating entry points, harborages, and runways.

Sticky Traps. These are used to locate harborage areas and estimate populations.

Flushing Agent. A pocket-sized can of pressurized air is useful for spot-flushing roaches out of inaccessible areas where trapping is not sufficient.

Utility Tools. A **pocketknife** equipped with various blades, **screwdrivers**, and **forceps** will enable you to open grills, electrical boxes, and other equipment for inspections. Carry **small vials** and **adhesive labels** to collect cockroach specimens. A **10-power (10x) hand lens** (small magnifying glass) will help you identify roach species. **Colored adhesive labels** can be used to mark hot spots, the location of traps and bait stations, and other areas. These tools can be kept in a tool pouch worn on a belt.

Knee Pads and Bump Cap. These are useful when crawling around for floor-level inspections.

Camera. A digital or Polaroid camera is useful for illustrating specific conditions (such as unsanitary situations or areas needing pest-proofing) in reports to decision makers or subcontractors not on the premises.

When to Inspect

Most inspections are conducted during daylight hours for the convenience of the inspector. However, since cockroaches tend to remain hidden during the day, it is difficult to assess the size and location of a population until after dark. Some individuals schedule at least one inspection after dark, when the majority of the cockroaches are active. This will give you more information about the location of the cockroaches and the level of sanitation at a time when the building is supposed to be clean. Begin your inspection with the lights off, if possible. A flashlight covered with a yellow filter (Roscoe #12) will prevent cockroaches from being disturbed while you look for their harborages and sources of food and water. Then turn on the lights and examine areas where cockroaches were observed. Note this information on your map.

Flushing

Flushing is a method of locating cockroaches in harborages that are difficult to see or reach. It is usually not necessary, especially if you conduct thorough inspections. If you do encounter situations where flushing is necessary you can use pressurized air (available in an aerosol can) or a hair dryer. A blast of pressurized air will flush the cockroaches from the cracks or crevices. Scattered cockroaches will soon return to the harborage, where they can be monitored and treated.

Monitoring with Sticky Traps

A visual inspection may not provide all the information needed about the location and number of cockroaches, so you may need to use sticky traps as well. Many brands of sticky traps are available, but most have a similar design. They are usually rectangular or triangular cardboard boxes with bands of sticky glue inside. Some models may contain a dark strip that releases a cockroach attractant.

The best sites for traps are near harborages and along cockroach travel routes. Cockroaches may not enter traps placed in the open or outside their normal routes of travel. Initially, it is best to place traps near all suspected harborages, water resources, and travel routes. However, avoid placing traps in extremely dusty or moist areas, because they will quickly lose their stickiness.

The more traps that are used, the sooner the cockroaches can be located. Later, fewer traps can be used for ongoing monitoring. Try to "think like a cockroach" as you decide where to place the traps. A monitoring map and the following examples will help in identifying the best spots.

Trap Locations

Keeping in mind the habitats cockroaches prefer (refer to Table 4 on page 35); place traps in the following types of locations:

- near and under sinks and stoves
- in or near motors of refrigerators and other appliances or vending machines
- in or near electric clocks, switch plates, and conduits
- next to computer equipment (where possible)
- near leaky plumbing fixtures
- near steam pipes or hot water pipes with insulating jackets
- near drains
- in drawers and cupboards
- in closets, on their floors and upper shelves
- in false ceilings or subfloor areas
- in areas where packaged goods and equipment are delivered and stored

Trap Placement

Cockroaches are **thigmotactic**, meaning they like to be in close contact with surfaces. So it is important that traps be placed against the wall, countertop, etc. and for the opening to be perpendicular to it so a cockroach traveling along the edge of the floor or wall can walk into the trap. Examples for trap placement include:

- floors and wall junctions
- floors and cabinets or other solid furnishings
- floors and appliances (stoves, refrigerators, vending machines)
- counters and walls
- hanging cabinets or shelves and walls

Number and date each trap before you put them out. Record the locations so none are neglected later. After 24 to 48 hours, count and record the number of cockroaches in each trap. Record the date and the number of cockroaches on the monitoring form.

Evaluating Trap Counts

Use the trap counts located on your map to pinpoint sites of infestation.

- Traps with high numbers of cockroaches indicate nearby harborages, and this is where management efforts should be concentrated.
- Traps with few or no cockroaches should be moved to other locations until all main harborage areas are pinpointed. For most programs, even one cockroach is enough to start management methods.

Post-Treatment Monitoring to Evaluate Efficacy

After the initial monitoring to pinpoint sites of infestation, treatment efforts can be concentrated at these locations. A week or two after treatment, traps should again be placed at the infestation sites to see how well management efforts are working. Place fresh traps at the previous locations and count the number of cockroaches in the traps after 24 hours.

If the trap catch has dropped considerably, the cockroach population has most likely declined and progress has been made. If not, another treatment strategy should be considered and greater efforts must be made to eliminate food, water, and harborage resources. To assess the continued success of treatments and detect any new infestations, continue to monitor after the IPM program is under way. Vigilance is important, and good record keeping will save time and energy.

Continuous Monitoring

To avoid future infestations, monitoring should be continued on a monthly or quarterly basis. This will alert pest management personnel to a new invasion before a population can become established. Cafeterias and other food-handling locations should be monitored at least once a month because of the constant transport of food and packaging (which may contain cockroaches) into and out of these areas.

MANAGEMENT OPTIONS

Education

Food-service and custodial staff play an essential part in any successful cockroach management program. Provide them with information on how to maintain cockroach-free kitchens, dining rooms, and waste disposal areas by applying the methods described below. Teachers, students, and other staff can play a significant role in maintaining a high level of sanitation in other areas of the school, so they also must be informed of their responsibilities.

Sample IPM Program for a Cockroach Infestation in a Kitchen

1. Use sticky traps to locate cockroach habitat.
2. Lower the cockroach population by vacuuming areas where traps indicate cockroaches are residing. Steam-clean infested kitchen equipment and appliances to remove grease if possible.
3. Initiate an education program for students, staff, custodians, and building maintenance personnel to gain cooperation.
4. Inspect all incoming items for cockroaches and their eggs.
5. Improve sanitation and waste management procedures to reduce cockroach food sources.
6. Reduce cockroach access to water and habitat by repairing water leaks, caulking cracks, and scheduling other building repairs.
7. If the previous activities have failed to reduce cockroach numbers, apply insecticidal dusts, baits, or gels in cracks and crevices in hard-to-clean areas. Blow boric acid or silica aerogel into wall voids, underneath appliances, or in other inaccessible areas where roaches harbor.
8. Monitor weekly and fine-tune management methods as needed until the problem has been solved. Continue monitoring monthly or quarterly to ensure that sanitation measures are maintained and to detect any incipient buildup of cockroach numbers.

Habitat Modification

Cockroaches need food, water, and harborage to survive, with harborage being the primary limiting factor. By modifying the environment of an infested building, you can reduce cockroach access to these resources. Repair leaking pipes and faucets, and caulk all cracks. With good-quality materials and a careful job, these alterations will produce a long-term reduction in the capacity of the structure to support cockroaches. It is important to note that the simple act of increasing the distance between food, water, and harborage will dramatically reduce the number of cockroaches a structure can support.

Limiting Areas for Eating

If you expect to contain and limit pest problems (including rodents and ants, as well as cockroaches), it is *very* important to designate appropriate areas for eating—and to *enforce* rules about eating only in these areas. The fewer designated eating areas there are, the easier it will be to limit pests.

Proper Food Storage

- Food not kept in the refrigerator should be placed in a sealed container. Cardboard boxes and paper are not cockroach-proof.
- Screw-top jars are cockroach-proof only if the lid has a rubber seal, because young cockroaches may be able to follow the spiral ridges to get into the jar.
- Glass containers with rubber gaskets or plastic containers with tight-fitting, snap-top lids are cockroach-proof.
- Remove food products from cardboard shipping containers before moving them into kitchens or storage areas. Transfer food packaged in cardboard or paper to plastic or glass containers as soon as the food arrives in the building. Do not bring shipping boxes into the food preparation area.
- Advise students and teachers not to leave unsealed food items in their desks or lockers. Any food kept in offices or classrooms should be stored in ant- and cockroach-proof containers.

Eliminating Water Sources

German cockroaches can survive for a couple of weeks without food but they must have regular access to moisture or they will die within a few days. Cockroaches find drinking water in:

- sink traps
- appliance drip pans
- drain pipes
- wash basins and tubs
- toilet bowls and flush tanks
- spills
- condensation on cold water pipes and windows
- leaky pipes and faucets
- pet dishes and aquariums
- vases
- beverage bottles
- various high-moisture foods

Much can be done to limit cockroach access to water by increasing sanitation and making repairs. Clean up spills and dispose of drink containers immediately after use. Keep aquariums and terrariums sealed with tight-fitting screened lids. Repair leaks and dripping faucets, then drain or ventilate moist areas. Kitchen surfaces should be kept dry when they are not in use, especially overnight.

Sample IPM Program for a Cockroach Population in an Office or Classroom

1. Initiate an education program for students, staff, custodians, and building maintenance personnel to gain cooperation with the program. Since monitoring and management activities will probably involve desks, computers, lighting fixtures, and other equipment used by staff, it is essential that they be given advance warning that work needs to be done. They also should be made aware that the problem cannot be solved without their cooperation.
2. Place sticky traps to locate roach habitat and prioritize areas to be treated.
3. Vacuum areas where traps indicate cockroaches are living.
4. Improve sanitation and waste management in office, snack, and lunch areas to reduce cockroach food sources.
5. Caulk cracks, and schedule other building repairs to reduce cockroach habitat.
6. If traps indicate cockroaches have infested computers or other electrical equipment, place bait stations next to infested machines. Never put baits directly on or inside computers or electrical equipment. Never use aerosol insecticides around computers because of the danger of shorting out the equipment. Give office and custodial staff a map showing where bait stations have been placed and request that the stations not be moved. **Pennsylvania law allows pesticide applications in schools only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator. The law also mandates a 7-hour reentry period for common access areas whenever pesticides are applied.**
7. If traps indicate that cockroaches have infested electrical conduits and are moving into the room through lighting switch plates, spot-treat the switch box with roach baits, gel, or dust.
8. If traps indicate that storage boxes containing paper files are infested with cockroaches, treat with bait stations or tiny gel bait placements.
9. If the previous activities have failed to reduce cockroach numbers sufficiently, apply roach baits, gel, or dust in cracks and crevices, and blow insecticidal dusts into wall voids, underneath counters, or in other inaccessible areas where roaches reside.
10. Baits incorporating an insect growth regulator (IGR) will help prevent future roach problems.
11. Continue monitoring until the cockroach population has been reduced to a tolerable level. Circulate a memo announcing that the cockroach problem has been solved and thank staff for their cooperation.
12. Continue monitoring on a monthly or quarterly basis to ensure that new infestations are detected early.

Eliminating Cracks and Crevices

- Start by caulking where cockroach populations are highest. If cockroaches remain a problem, caulk additional areas.
- Use silicon or mildew-resistant caulk around sinks, toilets, and drains.
- Before beginning the sealing process, vacuum and wash the area to eliminate egg cases, fecal material, and other debris.
- Caulk or paint over cracks around baseboards, wall shelves, cupboards, pipes, sinks, toilets, and similar furnishings in the locations indicated by monitoring traps.
- Screen drain covers in boiler rooms.
- Repair holes in window screens.
- Weather-strip around doors and windows where cockroaches may enter.
- Where gaps can't be sealed, they can be widened to make them less attractive to cockroaches. For example, the crack between freestanding shelving and adjacent walls can be widened by simply moving the shelving 1 inch away from the wall.

Eliminating Clutter
Removing clutter from areas near prime habitat such as sinks, stoves, refrigerators, and vending machines is one of the most important components of cockroach management. Clutter in these areas increases the available harborage near food and water. All useless, idle, or outdated items should be removed from the premises. Also, in-house storage of food products and paper goods should be kept to a minimum.

Installing Cockroach-proof Fixtures and Appliances
Whenever food preparation areas are scheduled for remodeling, the school district can take the opportunity to install cockroach-proof kitchen appliances and fixtures, such as stainless-steel open shelving units. The round shape of the metal and the general openness of the design offer few hiding places for cockroaches. Freestanding storage units and appliances on casters enable them to be rolled away from walls to facilitate thorough cleaning.

Sanitation
Sanitation disrupts and eliminates cockroach resources. This disruption of the environment can play a significant role in slowing cockroach population growth. Sanitation creates an additional advantage by making the cockroach environment so barren that they have a much greater chance of contacting baits or dusts (see the section on chemical controls on page 43).

Thorough daily cleaning is essential.

- Sweep and mop the floors.
- Drain all sinks and remove any food debris.
- If children regularly consume snacks in classrooms, vacuum and/or mop their floors daily.
- Periodically, give food preparation areas an all-inclusive cleaning, focusing on areas where grease accumulates: drains, vents, deep fat fryers, ovens, and stoves. Steam-clean drains and infested appliances. Thoroughly vacuum the area with a powerful vacuum cleaner (see the section vacuuming on this page).
- At the end of each day, remove all garbage containing food from the building to prevent cockroaches from feeding at night.
- Use soapy water to wash any bottles, cans, wrappings, and other items that have food residues clinging to them before storing them for recycling.
- If dishes cannot be washed immediately, it is very important that they at least be rinsed to remove all food debris.
- Place garbage in sealed plastic bags before putting it into a rodent-resistant dumpster or other storage receptacle.
- Keep garbage cans and dumpsters as clean as possible to deny food to cockroaches, as well as ants, flies, mice, and rats.

Brownbanded cockroaches can survive for some time without access to freestanding water, and they can live on soap or the glue on stamps, so simple sanitation alone will not have as significant an impact on a brownbanded cockroach population as it will on German cockroaches.

Physical Controls

Mechanical Barriers
Pennsylvania wood roaches can travel up the outside of a building and enter through an open window, weep hole, or ventilation duct. Screening these openings will prevent them from using these entry points. The males are also attracted to lights at night. However, Pennsylvania wood roaches are not generally a problem since they need high humidity to survive and usually die within buildings.

Screens can also be placed behind grill covers, and over vents and floor drains to prevent cockroach entry. Use caulk around the edges of the screen material to make a complete seal.

Cockroaches can travel within and between buildings on runways formed by electrical conduits, heating ducts and plumbing pipes. Seal openings around these runways with caulk, steel wool, or screening material.

Vacuuming
A strong vacuum can be used to pick up live cockroaches, as well as their egg cases and droppings. A vacuum with a HEPTA filter (capable of filtering out particles as small as 0.3 microns) will greatly reduce the amount of cockroach debris that becomes airborne during cleaning. Airborne cockroach debris (fecal material, body parts, and cast skins) can cause allergic reactions in sensitive people.

If the cockroach population is large, vacuuming is a way of quickly reducing the population. Once a large portion of the population has been eliminated, it is much easier to affect the remaining cockroaches with other treatment measures.

Although the dust in the vacuum bag will usually clog the cockroaches' breathing apparatus and suffocate them, you can vacuum up a tablespoon of cornstarch to be sure they die.

Trapping
This is not a good option due to cockroach allergens. Although traps will often capture a number of cockroaches, in most situations trapping alone will not produce a sufficient degree of control.

Chemical Controls

If nonchemical methods alone cannot solve the problem, integrating a pesticide into your management program may be warranted.

Pesticides must be used in accordance with their EPA-approved label directions. Applicators should always wear protective gear during applications.

All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Do not apply these materials in common access areas when occupied, and never apply them where they might wash into a drain or sewer unless otherwise labeled. .

When insecticides are needed, they should be applied as crack and crevice treatments or in a bait formulation. Crack and crevice treatment is the application of small amounts of chemical directly into cracks and crevices where insects hide or enter. This type of treatment is particularly effective against German cockroaches, which spend over 90 percent of their day hidden away in dark cracks, crevices, and voids. Broadcast spraying of insecticides greatly increases exposure risk and can lead to cockroach resistance when the pesticide's residual activity begins to decline and cockroaches are exposed to sublethal doses. This type of general treatment should be avoided whenever possible. If a broadcast spray is necessary, do it when students won't be present for a few days (Integrated Pest Management in Schools: IPM Training Manual, 1995). Note: Do not use spray formulation insecticides around computers, because they may short-circuit the equipment. Plastic bait stations can be placed in and around computer equipment if cockroaches establish a harborage inside.

Pennsylvania law allows pesticide applications in schools only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator. The law also mandates a 7-hour reentry period for common access areas whenever pesticides are applied. Contact the Pennsylvania Department of Agriculture for more information at (717) 772-5203.

Management Strategies

The most recent technological advances in cockroach management have been in bait formulations and insect growth regulators (IGRs). Other currently used products include desiccating dusts. Each of these treatment methods are discussed in detail below, including how they can be incorporated into a complete integrated cockroach management program.

Cockroach Baits

Cockroach baits consist of a toxicant mixed with a food source.

Current indoor bait formulations are applied as bait stations, gels, dusts or pastes. The bait station is one of the more popular application methods for educational facilities because the stations are easy to place and have residual (long-term) activity. Gel and dust bait formulations are also packaged for injection into cracks and crevices that are not readily accessible. Until recently, paste baits were very messy and required application with a putty knife. However, manufacturers have improved these products by repackaging the bait material into plastic syringes that are suitable for bait gun application. This greatly improves bait placement allowing paste baits to be applied into cockroach harborages as easily as gel and dust formulations.

Currently almost all baiting products available for indoor use are formulated using one of the following active ingredients: boric acid, fipronil, hydramethylnon, or abamectin. Some of these are in injectable gel formulations or bait station delivery systems. Other formulations include injectable gels in a syringe or bait gun, as well as bait stations, gel aerosols, and flowable bait dusts that can be injected into cracks and crevices.

Suggestions for Cockroach Baiting

(Frishman, 1994)

- Large blobs of bait in a few locations do not work well. Put out small amounts of bait in many locations.
- Put bait near harborage and between harborage and food. Review the Monitoring section for examples of cockroach harborage, and use the information collected from your monitoring traps.
- Once you have pinpointed harborage areas, place the baits along edges or in places where cockroaches are most likely to travel or congregate. If the bait is between the harborage and the food but not in a place where cockroaches are likely to run into it, the baiting program will fail.
- Sometimes an inch one way or the other can make all the difference in bait placement. If air currents are moving the bait odors away from the cockroach harborage, they may never find the bait.
- Do not place gel or paste baits in areas where they may get covered over with grease, flour, or dust. In areas where this might be a problem, bait stations should be used.
- Avoid harsh environmental conditions when baiting. In excessively warm areas, baits can melt and run. In cold environments, cockroaches do not move far and may

miss the bait. In very wet environments, the baits may grow mold and become unattractive to cockroaches. Boric acid baits hold up better in the latter situation, because boric acid naturally inhibits mold growth.

- Check baits frequently to be sure they have not been completely consumed or inadvertently removed by cleaning.

Insect Growth Regulators (IGRs)

Insect Growth Regulators (IGRs) are compounds that disrupt the normal growth and development of insects. IGRs are considered safe compounds. They generally have little toxicity to mammals because they act by disrupting hormonal processes specific to insects.

IGRs that mimic the juvenile hormones of cockroaches (and other insects) are called juvenile hormone analogues (JHAs). JHAs are chemical compounds whose structures are very similar to the hormones that cockroaches produce naturally to regulate development and reproduction. Juvenile hormone analogues disrupt both of these processes. For instance, JHAs interfere with the proper development of last instar cockroaches. Instead of the nymphs molting into reproductive adults, they molt into "adultoids," which often have twisted wings and are sterile. As more and more cockroaches in a population are exposed to JHA, the adultoids become predominant. Because the adultoids are unable to reproduce, the cockroach populations slowly decline over time. JHAs are a very effective method of long-term German cockroach management. However, because JHAs do not kill existing cockroaches, they are slow-acting, taking from 4 to 9 months to achieve management. For this reason, JHAs often are combined with residual insecticides. Most of the population is eliminated by the insecticide, and immature cockroaches that survive are sterilized by the JHA.

Inorganic Dusts

Inorganic dusts, such as silica gel and boric acid, have been used frequently for cockroach management. These dusts can be applied with a bulb duster into cracks and crevices under sinks, stoves, behind refrigerators, along baseboards, and in electrical outlets, cabinets, and wall voids. Silica gel is finely ground sand or glass that adheres to and abrades the protective waxes on the cockroach cuticle, which causes death from dehydration. Boric acid is a stomach poison that is picked up by cockroaches walking across dusted areas. The boric acid adheres to the cockroach cuticle and when the cockroach grooms itself, it ingests the boric acid. Refer to the section on ants for more information about inorganic dusts.

IPM for Fleas in Schools

INTRODUCTION

Fleas can be a problem in all parts of the country except in very dry areas. The most common species in school buildings is the cat flea (*Ctenocephalides felis*). This flea feeds on cats, dogs, and humans, as well as rodents, chickens, opossums, raccoons, and other animals. The dog flea (*C. canis*) and the human flea (*Pulex irritans*) are less commonly encountered.

IDENTIFICATION AND BIOLOGY

Adult cat fleas are small (⅛ inch long), wingless insects with powerful hind legs that are adapted for jumping and running though hair. The adult body is reddish-brown to black, oval, and laterally flattened. Unlike many other flea species, adult cat fleas remain on their host. After mating and feeding, adult female fleas lay oval, white eggs. These smooth eggs easily fall from the host into cracks, crevices, carpet, bedding, or lawn covering. A mature female flea can lay up to 25 eggs per day for three weeks.

Small, worm-like larvae (1/16 to 1/16 inches long) hatch from the eggs in 2 to 12 days. They have a distinct brown head and are eyeless, legless, and sparsely covered with hairs. The larval body is translucent white and a dark-colored gut can be seen through the flea's skin. Flea larvae feed on dried blood excreted by adults. They will also eat dandruff, skin flakes, and grain particles. Larvae live in cracks and crevices or on the ground where eggs have fallen. Under favorable conditions, they take 8 to 21 days to develop, but they can take up to 200 days under unfavorable conditions.

Larval fleas eventually spin silken cocoons in which they metamorphose into adults. The cocoons are sticky and attract dirt and debris, which camouflages them. Under optimal conditions, new adults are ready to emerge from their pupal cocoons within two weeks. They can, however, remain in their cocoons up to 12 months in the absence of a host or under unfavorable climatic conditions. Vibrations and/or elevated temperature stimulate adults to emerge from their cocoon. This ability to wait until a host arrives can result in a sudden increase of adult fleas when they emerge simultaneously from many cocoons.

As soon as the adult fleas emerge from the pupal case, they seek a host from which to take their first blood meal. Adults can live 1 to 2 months without a meal and can survive 7 or 8 months with one. They are the only stage that lives on the host and feeds on fresh blood.

The flea population builds up all year long in the form of eggs, larvae, and pupae, but rapid development into biting adults cannot be completed until temperature and humidity are optimal and host cues signal for adult emergence from the pupal cocoon.

ASSOCIATED PROBLEMS

Flea bites cause irritation, and sometimes serious allergic responses in animals and humans. Other, more serious, yet far less common problems are associated with the cat flea. Cat fleas can carry or transmit various organisms, such as *Yersinia pestis*, which causes bubonic plague; *Rickettsia typhi*, which causes murine typhus; and *Dipylidium caninum*, the double-pored dog tapeworm, which can live in dogs, cats, or humans.

DETECTION AND MONITORING

Fleas can be a problem in schools even when no pets are kept in the buildings. Adult fleas can be brought in on the clothing of staff, students, or visitors. Other possible sources include urban wildlife such as rats, feral cats, raccoons, opossums, chipmunks, squirrels, or birds that may live in unused parts of buildings. Detection is as simple as seeing fleas or noticing bites around the ankles of people in the building. Flea dirt—adult flea feces that dries and falls off a host—also may be visible.

Areas to Monitor

- In and around the cages of pets kept in classrooms (also check the pets themselves for signs of fleas).
- Places where animals might find harborage, such as basements, crawlspaces, attics, caves, rooftop structures, and secluded shrubbery near buildings.

Monitoring Traps

Flea Sock Traps

These are homemade, knee-high, white flannel booties that fit over the shoes and lower pant legs. When you walk through a flea-infested area, fleas will jump onto the flannel and become temporarily entangled in the nap where you can easily see and count them. Long, white

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Most of the information for this chapter was modified from:
IPM for Schools: A How-to Manual. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.
Richman, D. L. *IPM for Fleas in Schools*. University of Florida School IPM Web site at **http://schoolipm.ifas.ufl.edu/tp5.htm**. March 1998.

athletic socks worn over the shoes and trouser legs will also work, as will wide strips of sticky-backed paper wrapped around the lower legs (sticky side out). Socks can also provide protection from bites if a person must enter a severely flea-infested area for a short period of time.

Light Traps

These compact traps, roughly 4 by 6 inches in size, consist of a small electric light and a sheet of sticky paper. Adult cat fleas seeking a host appear to be attracted to both the warmth of the trap and the light emanating from it. Research has shown that fleas are most attracted to green light and are more attracted to light traps if the light is turned off for 10 seconds every 5 to 10 minutes; therefore, it is important to use a trap with a green light that can flicker on and off.

Light traps are especially useful for monitoring in offices or classrooms where no animals are present and the flea population is likely to be small. Check the traps once a week. If no fleas are caught by the second week, move the trap to another location or remove it. If the traps catch only a few fleas, the infestation is very small and can probably be managed with the traps alone. In this case, leave the traps in place until no fleas have been caught for at least a week. If more fleas are caught per trap in a week, this indicates a more serious infestation, and time must be devoted to finding its source (such as an animal living in or under the building).

Persistent Flea Problems

Persistent flea problems in buildings where there are no pets may indicate the presence of rodents or other wildlife. In this case, it may be helpful to have a professional identify the fleas. A flea's identity can be used to determine the host animal and where to search for the host or its nest.

Sample IPM Program for an Indoor Flea Situation

If monitoring has confirmed a high indoor flea population that requires an immediate response, the following IPM program can be used to manage the situation. A significant reduction of flea numbers should occur within 1 or 2 days.

1. **Protect Yourself**. Wear long plants tucked into boots or socks. For added protection, you may want to apply an insect repellent to pantlegs and footwear.
2. **Vacuum and/or Steam-Clean Infested Areas**. Since most fleas reside in carpeting, it should be thoroughly cleaned. In uncarpeted areas, or where carpeting cannot be steam-cleaned, concentrate vacuuming along baseboards, under furniture, behind doors, or in other areas where dust collects and flea eggs are protected from foot traffic. See Physical Controls on page 47 for more details.
3. **Apply an Insect Growth Regulator (IGR)**. After completing steps 1 and 2 above, spray carpets and floor with an appropriately labeled IGR (see Chemical Controls on page 48). The IGR will prevent pre-adult fleas that survive vacuuming or steam-cleaning from maturing into biting adults. **(Pennsylvania law allows pesticide applications in schools only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator. The law also mandates a 7-hour reentry period for common access areas whenever pesticides are applied.)**
4. **Apply an Insecticide If Needed**. The first three steps described above should reduce the flea population to a low level and keep it there while long-term measures (such as locating and removing wild animal flea hosts from the building) are undertaken. If sufficient management has not been achieved, apply a borate insecticide to carpeting or spot-treat infested areas with insecticidal soap or pyrethrin (see Chemical Controls on page 48). If adequate management has still not been achieved, a pest management professional should be contacted to apply a stronger insecticide, such as a synthetic pyrethroid. A combination of both an IGR and an appropriately labeled pesticide may be needed in some cases. All label directions should be followed to the letter and the applicant should wear appropriate protective clothing.
5. **Remove Any Wildlife Nesting In or Under Building**. If flea problems persist but no pet is present, check for wildlife in the vicinity of the building and remove any animals that are found. A residual insecticide may be needed under buildings to prevent flea migration indoors.

MANAGEMENT OPTIONS

An integrated management program for fleas can be designed by selecting from the following strategies and tactics. See the sample emergency flea management plan below.

Physical Controls

Wild Animal Removal

Wild animals can be trapped by trained animal management technicians. Consult your Yellow Pages or obtain recommendations from your Penn State Cooperative Extension county agent. Make appropriate repairs to exclude animals.

Vacuuming

- Vacuuming on a regular basis throughout the year will keep developing flea populations low by eliminating adult fleas and their eggs.
- Vibrations caused by vacuum cleaners will stimulate new adult fleas to emerge from their pupal sacs. These new adults will be either exposed to any residual insecticide on the floor or captured in the next vacuuming.
- Vacuuming is not very effective at capturing flea larvae in carpeting because the larvae coil themselves around the fibers. Vacuuming does, however, remove the dried blood on which the larvae feed.
- Use vacuum attachments to clean cracks and crevices. Caulk or seal these openings.
- Most fleas will be killed when dust in the vacuum bag suffocates them. To be sure they are killed, you can vacuum up a tablespoon of cornstarch.
- Vacuum badly infested areas thoroughly every day until the infestation is managed.
- When infestations are severe, you may need to supplement vacuuming with steam-cleaning or other management tactics.

Steam-Cleaning

The services of a steam-cleaning firm may be warranted when flea populations are severe. This process kills adult and larval fleas and probably some eggs as well; however, since the warmth and humidity from the steam also stimulates the remaining flea eggs to hatch a day or two after the cleaning, some fleas may reappear. If the other steps recommended in this section are followed, the few fleas that hatch after steam-cleaning should represent the last of the flea population.

Flea Combs

Classroom pets in a flea-infested room should be combed regularly with a special flea comb that can be purchased at a pet store. Fleas and eggs removed from the animal should be dropped into soapy water.

Laundry

Wash removable floor coverings, such as rugs, located in areas where there are known infestations. Any bedding for classroom pets should be washed regularly.

Ultrasonic Devices

It has been suggested that ultrasonic flea collars keep fleas off pets, but recent investigations have shown these devices to be ineffective.

Heat

Tests have indicated that cat flea larvae die after exposure to 103°F for one hour, and techniques to raise the temperature in a room to provide this exposure have been developed. The heating process uses a common heating unit modified to include special blowers and flexible ducts. Companies have been using heat to kill termites and wood-boring beetles for a number of years, and now some companies are experimenting with heat to manage fleas. One potential problem with this technique is that fleas can burrow into carpets and upholstery, and perhaps escape lethal temperatures.

Drying or Flooding Infested Areas Outdoors

Outdoors, organic matter can temporarily harbor flea larvae. Either drying out these areas or saturating them with water will kill eggs and larvae. You can also treat these areas with insect-attacking nematodes (see Biological Controls below) or with an insecticide labeled for outdoor use (see Chemical Controls on page 48).

Biological Controls

Beneficial Nematodes

Insect-destroying nematodes (*Steinernema carpocapsae*) can be applied to the lawn as a spray. These microscopic, worm-like organisms live in the soil and kill insects by entering their bodies, feeding on their tissue, and releasing harmful bacteria. They do not affect people, pets, or plants. When the nematodes mature and reproduce, the nematode larvae leave to search for other hosts. They cannot move far (only 1 or 2 inches) and die if they fail to contact other insects. The nematodes sold for flea management are native to the United States and are found naturally in the soil nationwide. They will not adversely affect earthworms, but may attack insects other than fleas.

Nematodes may not be effective in some situations, and may also require monthly applications (Mallis, 1992).

Tips for Using Nematodes

- Use the number of nematodes recommended by the manufacturer.
- Treat outdoor areas where you have found evidence of sleeping animals or areas that you know are regularly traveled by animals.
- Moisture is critical to the effective use of nematodes, so water the area before and after the application.

Chemical Controls

If nonchemical methods alone are ineffective, or only partially effective, then integrating a pesticide into your management program may be warranted.

Pesticides must be used in accordance with their EPA-approved label directions. **Pennsylvania law allows pesticide applications in schools only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator. The law also mandates a 7-hour reentry period for common access areas whenever pesticides are applied.** Applicators should always wear protective gear during applications. All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. These materials should not be applied in common access areas when occupied, and never where they might wash into a drain or sewer unless otherwise labeled.

Insecticidal Soap

Insecticidal soap products can be found in pet stores and sometimes hardware stores. Some of these products contain pyrethrins.

Insecticidal soap can be used on pets, rugs, floors, and other places where flea eggs or young fleas may have collected. Outdoor areas also can be treated with insecticidal soap to reduce adult populations. Because this soap can kill a wide variety of insects, mites, and other arthropods (many of which are beneficial), it should be used outdoors only in spot treatments where wild animals nest, and only when flea infestations are large.

Diatomaceous Earth and Silica Aerogel

These are dusts that can be used for flea management. Diatomaceous earth is made from fossilized diatoms, and silica gel is produced from sand. Both these products kill insects through desiccation: they abrade the wax and oil on the insect's outer covering, leading to dehydration and death. Although these materials are not poisonous to humans, the fine dust travels freely through the air and can be irritating to the eyes and lungs; therefore, use a dust mask and goggles during application. Silica gel and diatomaceous earth are sometimes formulated with pyrethrins, which are discussed below.

How to Use Diatomaceous Earth and Silica Aerogel

- Lightly dust upholstered furniture that is suspected to harbor fleas. Be sure to work the material into cracks and crevices.
- Lightly dust rugs or pet bedding.
- Apply to infested carpeting, leave for a couple of days, and then vacuum up.
- Dust crawl spaces, wall voids, attics, and other similar spaces where you suspect animals of nesting or resting.
- Do not use in moist environments; neither material works well when wet.

Citrus Oil Extracts (D-Limonene/Linalool)

D-limonene and linalool are citrus-peel extracts that have been used for years as food additives. Products that contain d-limonene kill larval and adult fleas, while those containing both ingredients kill all flea stages. EPA-registered citrus shampoos are mild enough to use on young animals, but veterinarians caution that some cats may react negatively if the material is applied in excessive concentrations. Citrus sprays also can be applied to animal bedding, but they should not be used outdoors or to spray entire rooms.

Borates

Borate products worked into the nap of the carpet can be used to manage fleas. This treatment is an intestinal poison which acts on flea larvae that have ingested it. These products may be effective for up to a year. This product is sold through veterinarians, but application of borates by a pest management professional is recommended in schools.

Imidacloprid and Fipronil

Both imidacloprid and fipronil are available through veterinarians as spot-on oils that are applied to the shoulder area of a cat or dog. These materials become distributed over the body within a few hours. (Consult a veterinarian before using either of these products on a pet other than a cat or dog). These insecticides are relatively nontoxic to mammals and kill almost all the fleas on the pet within 24 hours of treatment. Both products continue to kill fleas for at least 30 days after treatment. However, fleas may feed, mate, and lay eggs before they die.

Pyrethrins and Synthetic Pyrethroids
There are a number of flea management products containing pyrethrins and synthetic pyrethroids which are used as spray treatments to reduce the number of fleas. These products should be applied by a pest management professional.

Insect Growth Regulators
Insect growth regulators (IGRs) inhibit the development of immature fleas, but do not kill adult fleas. Use of an IGR product (or a borate product) in conjunction with an adulticide (imidacloprid, fipronil, pyrethrins, or pyrethroids) prevents development of immature fleas and kills adult fleas. Methoprene and pyriproxyfen are available in pet sprays, pet collars, and spot treatments. Fenoxycarb is available through professional pest management companies and is for outdoor use only. Lufenuron, a medicine for dogs and cats, is available only from veterinarians. It manages fleas by preventing eggs from hatching.

IPM for Flies in Schools

INTRODUCTION

Many species of flies can be problems in schools. Each kind of fly has a distinct breeding site inside or outside the school building. To manage pest flies, you must know which fly is causing the problem and where it is breeding. Common pest flies encountered in schools can be identified by characteristics shown in Table 5.

Garbage- and Manure-Breeding Flies

IDENTIFICATION AND BIOLOGY

House flies, dump flies, blue and green bottle flies, and others that breed in food wastes (garbage) and/or animal feces generally are referred to as "filth flies."

Sometimes flies are confused with wasps; however, flies have two wings, while wasps and all other winged insects have four wings arranged in two pairs. Wasps, unlike flies, fold their wings alongside their bodies when at rest. Most pest wasps are colorfully marked with yellow, red, black, and white, and have narrowly constricted waists. Generally, wasps are less likely to come indoors, are aggressive in their flight around foods, particularly sweets, and are larger than filth flies. Filth flies are not aggressive and do not bite. The cluster fly, which is also larger than the filth flies, can be identified by its stout body with crinkled yellow hairs.

Filth flies pass through four distinct stages in their life cycle: egg, larva (maggot), pupa, and adult. Adult female filth flies look for moist places with the right smell to lay their eggs. This can be in food waste in a garbage can or dumpster, in dog or cat feces, in dead animals, in kitchen drains, in grass clippings allowed to rot in a pile, and even in moist soil that is mixed with garbage. The larva hatches from the egg and grows until it is ready to form a puparium (a kind of cocoon), from which an adult fly will emerge. Once the adult fly emerges, it doesn't grow any larger; small flies do not grow into larger flies.

DAMAGE

Flies that invade cafeterias and kitchens are not just a nuisance. They also carry bacteria and other microbes that can contaminate food, utensils, and surfaces.

TABLE 5.

Common Flies Found In and Around Schools in Pennsylvania

Species	Description	Sources of Infestation
House fly *Musca domestica*	1/4–5/16 inch long; gray; 4 stripes on thorax	garbage, human and animal feces
Blow flies		
Green bottle fly *Phaenicia sericata*	1/4–5/16 inch long; shiny green to bronze	garbage containing mixtures of animal and vegetable matter; dead animals; fresh meat; enters buildings less frequently than house flies
Blue bottle fly *Cynomyopsis cadaverina*, *Calliphora* spp.	1/4–5/16 inch long; thorax dull; abdomen metallic blue	exposed meat, feces, overripe fruit, and other decaying vegetable matter; enters buildings in cool season
Cluster fly *Pollenia rudis*	larger than house fly, 1/2 inch long; dark gray with distinctive yellow hairs; adults sluggish	larvae parasitic on earthworms; adults enter houses in fall
Fruit fly *Drosophila* spp.	1/8 inch long; yellow-brown	fermenting fruit and vegetables, other moist organic matter
Phorid fly (Humpbacked Fly) *Megaselia scalaris*	1/16–1/4 inch long; more hump-backed in appearance than fruit flies	decomposing organic matter, including vegetables, fruit, flesh, and feces
Moth fly (Drain Fly) *Psychoda spp.*	1/16–1/4 inch long; dark or grayish with wings densely covered with hairs	eggs, larvae, and pupa often found in slime or muck in drains, sewage disposal beds, moist compost, and garbage containers; adults found near same areas

Most of the information for this chapter was modified from:
IPM for Schools: A How-to Manual. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.
Information on moth flies was adapted from Lyon, W. F. *Drain Flies*. The Ohio State University Extension Fact Sheet HYG-2071-97, and Jacobs, S. B. *Moth flies in the home*. The Pennsylvania State University, Entomology-NP-6, 1998.

DETECTION AND MONITORING

It is important to correctly identify the problem flies and pinpoint their breeding sites. Some of the characteristics listed in Table 5 can help you with identification. Specimens also can be taken to a Penn State Cooperative Extension county agent, who should be able to assist in identification.

To collect specimens inside, use sticky flypaper or gather dead specimens from windowsills and light fixtures. Outside, trapping is one of the easiest methods of catching flies for identification (see page 53 for guidelines on trap construction, placement, and baits). If adult flies consistently avoid baited traps, the pest fly may not be a filth fly.

MANAGEMENT OPTIONS

To manage flies, you must find and reduce breeding sites, install and maintain screens to keep flies out of buildings, kill those flies that do get inside with a fly swatter or flypaper, and reduce or eliminate the odors that attract flies.

In a school with a frequent waste removal program, it is very possible that few flies are breeding on the school property. It is more likely that odors from dumpsters, garbage cans, kitchens, and cafeterias are attracting flies to the school from the surrounding neighborhood. House flies and blow flies, the species that most commonly invade buildings, usually develop outside and follow odors into the building. They can also be pests when students or staff are eating outside. In schools where waste removal is infrequent, fly populations can be breeding at the waste collection site.

Habitat Modification

Modifying habitat is one of the most important aspects of fly management. It is impossible to manage filth flies without controlling wastes and odors.

Food Waste

- All food waste from the kitchen, cafeteria, and other areas should be separated from other garbage, drained so it will be as dry as possible, and then stored in sealed plastic bags before discarding.
- Place containers with small amounts of food waste, such as milk or yogurt cartons, into sealed plastic bags before disposal. This will reduce access by flies.
- Promptly fix drains or electric garbage disposal units that leak, or drains that allow food waste to accumulate under sinks or floors. Leaky drains can attract many species of flies. Remove any food waste that has accumulated under sinks or floors or in crawl spaces or basements at the site of the broken drain, and then clean the area thoroughly.

Other Garbage

- In food preparation areas, rinse all cans, bottles, and plastic containers before recycling or discarding.

Exterior Garbage Cans and Dumpsters

- Inform students, teachers, and staff about the importance of placing garbage inside the proper containers. Garbage should not be left lying on the ground.
- To avoid attracting flies into the building, place dumpsters and recycling containers upwind from the outside doors of the school, particularly doors to the kitchen or cafeteria. When dumpsters are downwind, flies are attracted to the waste odors and then find the odor trails that the breeze blows down from the doorways. Following these odor trails, they find their way into the building.
- Wastes should be collected and moved off-site at least once a week. Since flies breed faster in warm weather, garbage collection twice a week may significantly reduce fly problems.
- Make sure garbage can and dumpster lids seal tightly when closed and remain closed when not in use. Do not leave lids open at night; garbage can attract other pests, such as rodents. Repair or replace garbage cans that have holes or lids that do not close tightly.
- Regularly clean garbage cans and dumpsters to prevent the buildup of food waste. Use a high-pressure stream of water or a brush and soapy water, if necessary. A solution of borax and water will eliminate odors. Do not allow soured milk to collect in trash receptacles; it is a powerful attractant to flies. If possible, dumpsters should be fitted with drains so they can be hosed or scrubbed out as needed. Another option is to require the refuse company to clean the dumpster or replace it with a clean one more frequently. Some pest management companies will power-wash dumpster and dumpster areas as part of their service.
- Flies can develop in soil soaked with water used to clean garbage cans and dumpsters. Check these areas regularly. If you see maggots, scrape them up along with the soil and dispose of everything in a tightly sealed plastic bag.
- Inspect dumpsters and other outdoor trash receptacles daily, and remove any wastes lying on the ground.
- Garbage cans on the school grounds should have removable domed tops with self-closing, spring-loaded swinging doors. Cans should be lined with plastic bags that can be tightly sealed and removed daily.
- If children do not have access to dumpsters, baits inside and residual insecticides on the outsides of dumpsters work well.

Animal Feces
Remove droppings promptly and put them into plastic bags that are sealed before disposal. Dog feces that dry quickly may attract adult flies with their odor, but are unlikely to host many maggots. Droppings that remain damp because of humidity or rain can breed a number of maggots.

Odor
Flies can detect odors across long distances. Smells of souring milk from hundreds of containers thrown in dumpsters can attract thousands of flies from the surrounding neighborhood. Storing garbage in sealed plastic bags and having cans and dumpsters cleaned and emptied frequently to eliminate odors is very important. Removing pet feces also helps to reduce odors that attract flies.

Flies attracted to open kitchen or cafeteria doors, or to dumpsters or garbage, will rest on nearby walls, eaves, and rafters. While resting, they leave fly specks, which have a strong fly-attracting odor. These brown- to cream-colored specks should be washed off with an odor-eliminating cleaner (a mild solution of borax and water can be particularly effective); otherwise, they will continue to attract flies.

Physical Controls

Screens
Install screens over windows, doors, and vent holes to prevent flies from entering buildings. Weather-stripping or silicone caulk can be used to ensure a tight fit. Torn screens can be repaired with clear silicone caulk. Screen doors should be fitted with springs or automatic closing devices that close the screen door firmly after it is opened. External doors that cannot be screened should be fitted with automatic closing devices, and/or vertical strips of overlapping plastic that allow human access but prevent fly entry. "Air curtains" that force air across openings are another alternative to screen doors.

Fly Swatters
In many instances, the old-fashioned fly swatter is the safest and quickest way to kill flies that have found their way into a room. Aim the fly swatter about 1½ inches behind the fly, rather than directly at it, because research has shown that when a house fly takes off from a horizontal surface, it jumps upward and backward. Stiff plastic swatters seem to work better than wire-mesh ones. The fly's unblurred range of vision is about 1½ feet, and the swatter can be moved to this distance before striking.

Flypaper
Sticky flypaper is effective at catching flies because it takes advantage of their natural habit of moving up to the ceiling to rest. It will take several days for a new strip of flypaper to start catching flies. Use a number of strips at a time and replace them when they are covered with flies or when they begin to dry out. Flypaper can be very useful in areas where there are too many flies to kill with a fly swatter, and where aesthetic appeal is not of primary importance. Flypaper is also a useful monitoring tool. Do not place flypaper or sticky strips above or near food preparation areas.

Fly Traps
Fly traps can be used to reduce adult fly populations, capture specimens for identification, and monitor the effectiveness of management programs. Fly traps are not toxic and are more selective than using insecticide. Traps need to be serviced regularly, placed appropriately, and repaired or replaced when damaged.

Trapping Flies Indoors
Electrocuting light traps often are used indoors. The Food and Drug Administration states that they should be "installed no closer than 5 feet from exposed items." Light traps will not work well in a room with many and/or large windows, because the bright light coming in the windows is a much more powerful attractant than the comparatively weak light coming from the trap. Light traps do work well at night.

Some companies are now producing fly traps that lure the flies to a hidden glue board with a near-UV black light specially designed to attract flying insects. These were developed for cafeterias, fast food operations, and school lunchrooms.

Contrary to the advice provided in some promotional literature for ultraviolet light or electrocutor traps, these traps should not be used outdoors. They are relatively nonselective in the insects they attract and will kill many more beneficial and innocuous insects than pests.

The following are key points to remember when using light traps for indoor flies:

- Use the number of traps recommended by the manufacturer, or, as a general rule, one trap for every 30 feet of wall.
- Ideally, traps should be mounted 3 feet from the floor on the perimeter walls of the room, because hungry flies circle the perimeter of a room close to the floor when looking for food. They should also be placed 5 feet away from any open food and 25 feet from any doors or windows. Traps work best in rooms without windows.

A pest management professional can help with trap placement recommendations.

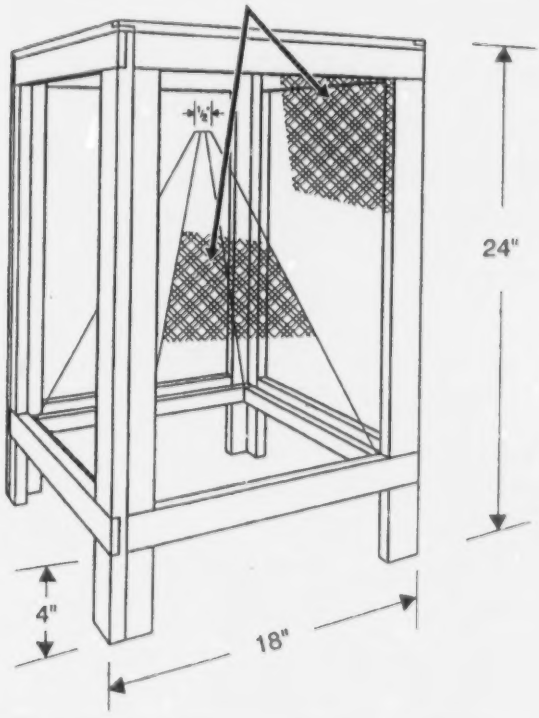
- Empty and clean the traps weekly to prevent dead flies from becoming an attractive food source for other insects.
- Replace lamps at least once a year.
- The more expensive black light "blue" bulbs do not attract more flies than regular black light bulbs.
- The lamp should be directed toward the interior of the building. Do not place traps where flies that are outside can see the light bulb. This may attract more flies.
- Place traps near odor sources such as cooking areas, garbage cans, and outdoor restrooms, since odors will be more attractive (especially from a distance) than the light.

Trapping Flies Outdoors

To capture flies outside, use traps with a screen cone suspended above the bait. These cone-type traps take advantage of the fly's habit of flying or walking toward light. Cone traps can be easily made from wood and aluminum or plastic screening; use the dimensions shown in Figure 3. Flies are attracted to the bait in the pan under the trap. Once the flies are under the trap, the brightest spot they see is the hole in the cone above them. They walk up through the hole and are trapped in the outer screen cage. Since flies are attracted to the light and it is always lighter above them, they can not find their way back out through the hole in the cone.

FIGURE 3.

Cone Trap Diagram



A bait pan is placed beneath the cone. Make sure the top edge of the bait pan is *above* the bottom edge of the trap. The top also is made of screening, and should be hinged (to empty the trap) and closed with a hook and eye. Weather-stripping or a strip of foam or cloth glued to all four sides of the underside of the lid will prevent flies from squeezing out.

The following are key points to remember when trapping flies outdoors.

— Trap placement is important.

- If an area has a small or moderate fly problem, traps placed close to buildings can attract flies from all over the neighborhood and make the problem worse. It is better to set the traps close to fly breeding sites, with any prevailing breeze blowing from the trap toward the breeding area.
- Do not set traps near doorways or entrances to buildings.
- Place traps away from outdoor areas that are used for eating or recreation.
- Generally, traps are most effective when placed on the ground, but they can be hung over the openings of dumpsters and from buildings or fences as well. Traps hung in these areas must not interfere with the opening and closing of the dumpster, and should be placed in areas where people will not tamper with them and will not be offended by the bait odors.
- Place traps in sunlight. Flies are more active in sunlight, both outside and inside the trap.

— Empty the trap when dead flies cover about one quarter of the cone.

- Do not release live flies that are in the trap. Kill them by enclosing the trap in a plastic bag and placing it in the sun. After the flies are dead, the contents of the trap should be poured into the plastic bag, sealed, and discarded in a dumpster or garbage can.

— Do not clean the trap between uses.

- The smell of the millions of fly specks deposited on the screen is very attractive to flies.

Fly Bait Recipes

Bait is important to the performance of the trap. Here are some recipes and tips on using them.

BELTSVILLE BAIT

(from Pickens, et al., 1994)

This makes a dry bait that can be easily stored for a considerable time. It must be mixed with water before using.

Ingredients

1 pound granulated sugar

1 pound baking powder (double-acting type)

2 ounces dry active yeast (baking yeast)

6 ounces air-dried blood or freeze-dried fish meal

¼ cup honey

2 tablespoons* water

*Quantity of water needed may vary with the humidity of air when mixing. Use only sufficient water to bind dry ingredients together when they are compressed.

Procedure

Mix ingredients thoroughly. Press mixture into a plastic ice-cube tray to form cubes. Invert the tray to dump the cubes, and let them dry to form hard blocks. To use the bait, add 2 cubes of bait to 2 quarts of water. Place bait in a wide-mouth pan beneath a cone-type trap. Flies are attracted to this bait from only a short distance, so traps should be placed within 6 feet of areas where flies are active. Bait pans should be cleaned and baited every 1 to 2 weeks and should be kept filled with water.

LIQUID YEAST BAIT

(from Satrom and Stephens, 1979)

This recipe makes 7–9 portions of liquid bait for use with a cone trap. It can be stored 20–30 days once it is ready for use.

Ingredients

2 quarts tepid (not hot) water (95°–105° F)

1 cup and 3 ounces active dry yeast (baking yeast)

2 tablespoons ammonium carbonate (optional*)

*Ammonium carbonate is available from chemical supply houses and will improve the odor of the bait.

Mixing the bait

Use a plastic (not glass) narrow-necked gallon jug with a screw cap for mixing, ripening, and storing bait. Bleach or milk jugs work well. Wide-mouth containers will not produce effective bait.

Mix all the above ingredients in the jug. Important: With cap lightly sealed, allow mixture to begin to ripen (see ripening instructions below). It will foam up at first. After it subsides (1–2 days), tighten the lid and continue ripening till very smelly (2–9 additional days). Gases must escape while bait is foaming up (loose cap), but bait must finish ripening without air (tight cap) to attract flies.

Ripening the bait

Allow bait to ripen 4–10 days in a place where temperatures remain above 60°F during the night and day. Bait is ripe when it is very smelly, with a musky, penetrating odor. Warm daytime temperatures will make up for slightly cooler (less than 60°F) nights, but in general, the warmer the average temperature, the faster the bait will ripen. Because of its heavy odor, the bait should be ripened in a well-ventilated area where it will not offend people. Do not ripen or store the bait in direct sunlight. Extreme temperatures can build within the jug, kill the yeast, and cause gases to expand enough to pop off the lid or break the jug.

Storing the bait

To maintain potency, store bait with the cap kept tight. Open the jug only when necessary to refill the bait pan. Do not store in direct sunlight.

NOTE: Ripened bait should be treated as a decaying food material. It can cause gastrointestinal disturbances if ingested.

Using the bait

Stir or shake the bait supply each time before adding to the bait pan. Pour about 1 cup (8 ounces) of bait in a wide pan on a level surface under the trap. Be sure the edge of the pan is higher than the bottom edge of the trap frame.

The bait is effective in the pan for at least 3 to 5 days. It attracts more flies on the first day, and then gradually declines thereafter. Don't let the bait dry out.

- Liquid bait, either the *Yeast Bait* or the *Beltsville Bait*, is a superior attractant that will not breed flies unless it is allowed to dry to a sludge. If either of these baits contaminates clothing and hands, use baking soda and water to remove the odors.
- *Yeast Bait* has a foul odor that is particularly attractive to female flies because it smells like a good place to lay eggs. This bait will lure flies even from the most attractive breeding sites.
- *Beltsville Bait* will attract male flies as well as females because it contains sugar. This sweet bait can be used in cool weather when the main aim of trapping is to reduce the total number of flies rather than to suppress breeding.
- Baits such as decaying meat or fish scraps will attract mainly blow flies and flesh flies. These baits should always be put inside a rolled down plastic bag and then placed in the bait pan. Periodically check the bait so that it does not become a breeding site for flies. The larvae feeding on the bait can crawl out of the plastic bag and away from the trap to pupate. If larvae are found in the bait, the plastic bag should be sealed, thrown away, and replaced with a new bag and bait.

- Sex pheromone baits for flies do not last long and do not attract flies from a distance. They are likely to be more expensive and less effective than food baits that can be made with common materials and attract both sexes.
- Poisons are not needed in the bait. Flies are more attracted to the live flies in the trap than they are to dead ones. However, if fruit flies begin breeding in the trap, a granular bait toxicant should be added.
- The top edge of the bait pan must be at least ½ inch above the bottom edge of the trap. If flies can sit on the top edge of the bait pan and look out under the trap, trap catches will be poor.

Prevent excessive amounts of water from getting into the trap. If dead flies in the trap get wet and begin to rot, they may attract blow flies that will lay their eggs on the outside of the screen.

When the tiny blow fly larvae hatch, they crawl through the screen to feast on the rotting mass of flies. This turns the trap into a messy breeding site for flies.

- Do not place traps where sprinklers will get them wet.
- In areas where there are frequent rainstorms, it may be necessary to fit the trap with a clear Plexiglas top.

Chemical Controls

Except for odor-eliminating chemicals (such as borax) and baits, pesticides are not recommended for fly management. However, where children do not have access to dumpsters, baits inside and residuals on the outsides of dumpsters work well.

Borates

Low concentrations of borax in water can be used to eliminate fly odors. This solution is particularly effective for removing fly specks from walls and eaves, and for rinsing out garbage cans and dumpsters. These solutions should not be used near ponds, streams, lakes, or other bodies of water, and should not be poured onto plants.

Fruit Flies, Cluster Flies, Phorid Flies, and Moth Flies

IDENTIFICATION AND BIOLOGY

Fruit Flies

Fruit flies are small flies commonly seen flying around ripe fruit, especially bananas. They are about ⅛ inch long. They lay their eggs near the surface of fermenting fruits and vegetables and other moist organic materials (including damp mops and cleaning rags, as well as residues in bottles, cans, garbage disposals, and drains). Their life cycle, from egg through maggot and pupa to adult, takes little more than a week, and the number of flies that can be produced by a single piece of fruit is enormous. These flies are most often a problem in late summer and early fall, so careful storage of fruit and vegetables is necessary at these times of the year.

Cluster Flies

Cluster flies are larger and darker than house flies and have a distinctive yellowish color caused by the crinkled yellow hairs on their bodies. In the summer, cluster flies lay their eggs in soil, where the maggots parasitize earthworms. Soil containing many earthworms is a common source of these flies. In the fall, the adults can be seen clustering on the south and west sides of buildings. As the weather gets cooler, these flies begin looking for sheltered places to spend the winter and often enter buildings.

Phorid Flies (Humpbacked Flies)

The most common phorid fly, *Megaselia scalaris*, is small (1/16 to ⅛ inch long) with a yellowish-brown body and light brown wings. The adults seem reluctant to fly, and they run around on walls, windows, and tables with a characteristic quick, jerky motion. The females are strongly attracted to odors and lay their eggs on or next to decaying material, both plant and animal. Food sources for the larvae are highly varied, from decomposing fruit, vegetables, and meat to open wounds in animals and people to human and animal feces. The life cycle from egg to adult takes from 14 to 37 days.

Moth Flies (Drain Flies)

Moth flies (*Psychoda* spp.) are about 1/16 to ¼ inch long, fuzzy, dark or grayish insects. Their body and wings are densely covered with hairs. Wings, appearing too large for the body, are held roof-like over the body when at rest, giving a mothlike appearance. During the day, adults often rest in shaded areas or on walls near plumbing fixtures and on the sides of showers and sinks. During the evening, these flies can be seen walking about drains and sinks.

They may breed in large numbers at sewage filter plants and then be carried by prevailing winds to nearby buildings up to a mile away. Adults are small enough to pass through ordinary window screening.

MANAGEMENT OPTIONS

Fruit Flies

Fruit flies are most active from early summer through early fall. Problems with these flies can be avoided by ripening fruit in paper bags. Seal the bags by folding the top over several times and closing them with paper clips or clothespins. Once fruit is ripe, store it in the refrigerator. Careful storage of fruit during the rest of the school year may not be necessary.

If an infestation is discovered, look for and remove the material that is breeding the flies. Begin by searching for the obvious sources, such as ripe fruit and vegetables, then look at water from refrigerators, humidifiers, or sink drains that may be fermenting; spoiled animal food; or even damp, sour mops or rags. Areas outside the building near windows and doors should be checked for rotting vegetable matter. All breeding sources should be removed and disposed of in a sealed plastic bag. Make sure that screens and windows near food preparation areas are in good repair.

Fruit Fly Trap

To make a simple trap for fruit flies, combine 1 cup of vinegar, 2 cups of water, and 1 tablespoon of honey in a 2-liter soda bottle. Replace the cap, shake the mixture well, and punch holes in the side of the bottle above the liquid so the flies can get in. Using string, hang the bottle about 5 feet above the ground. Periodically, the dead flies should be strained out and the liquid reused.

Cluster Flies

Cluster flies are not as strong fliers as house flies and can easily be killed with a fly swatter or removed with a vacuum. Cluster flies also can be allowed to exit by opening the window. They can find their way into buildings through unscreened doors and windows, openings under siding and around roofs, unscreened ventilating spaces, cracks around windows, and holes where wires penetrate the walls of the building. During warm winter periods, cluster flies hidden in buildings become active and are attracted to windows.

Phorid Flies

Phorid flies breed in diverse sources of organic matter, so it may take considerable sleuthing to find their breeding sites. Once a site is found, it must be thoroughly scraped, cleaned, and dried. Large infestations of these flies are often the result of broken drains or garbage disposals that allow organic matter to accumulate in out-of-the-way places such as wall voids, under floors, in basements, or in the soil of crawl spaces.

Moth Flies

Moth flies do not bite humans, but may become a nuisance by their presence in large populations. Concentrate on eliminating larval breeding sites from drains in floors, sinks, wash basins, showers, and similar places. To determine if the flies are coming from a drain, place a glue board, sticky side down on a collar made of cardboard, over the drain during a down time. Leave in place overnight or for a few days to monitor for the flies.

Often the most effective method is to clean the drain pipes and traps regularly to eliminate the gelatinous, rotting organic matter, thus eliminating the larval food source. Infestations developing in drains often can be eliminated by flushing these areas with sink cleaning materials followed by very hot water. Clean dirty garbage containers, standing water in air conditioners, or other sources of stagnant water in the area.

IPM for Head Lice in Schools

INTRODUCTION

Few conditions seem to cause as much concern and anxiety in schools and homes as an infestation of head lice in the hair of children. Many people associate head lice with filth, but in reality these insects do not discriminate according to social class or level of personal hygiene.

Lice are parasites of humans. Three types of lice can infest humans: head lice, body lice, and crab lice. This section deals primarily with *Pediculosis humanus capitus*, the head louse.

IDENTIFICATION AND BIOLOGY

Head lice (*Pediculosis humanus capitus*) are wingless insects measuring about $\frac{1}{8}$ inch long. They are flat and gray-brown in color, with special mouth parts for piercing and sucking. Their laterally positioned eyes are small, and the female is generally larger than the male. Adult lice have six legs with large tarsal claws, which enable them to cling to hair shafts of a host.

Lice are unable to jump or leap from victim to victim, but adults and newly hatched nymphs can move rapidly from hair shaft to hair shaft. They live their entire life as an external human parasite. They do not survive for more than one or two days without a blood meal.

Eggs of lice, called nits, are glued to hairs of the head near the scalp, especially near the ears and on the back of the head. A female can lay 8 to 10 eggs per day and a total of 50 to100 eggs during her life. Usually the nits hatch in 7 to 10 days, leaving behind empty shells attached to the hairs. (Unhatched nits are clear in color; hatched or empty nits are milky in color, with a missing top). The young lice must feed within 24 hours, or they die. It takes about a week to 12 days for lice to become adults.

When lice feed on human blood, they inject their saliva into the host to prevent clotting. Meanwhile, they deposit fecal material onto the scalp. People previously unexposed to lice usually experience little irritation from their first bite. After a short time, some individuals become sensitized to the bite and experience a general allergic reaction, which may involve reddening of the skin, itching, and general inflammation.

Body lice (*Pediculosis humanus corporis*) are practically indistinguishable from the head lice.

The chief features distinguishing them are:

- Body lice attach eggs to clothing fibers instead of hair.
- Adults and nymphs spend most of their time on clothing. They move to the skin to feed and are most numerous where clothing is in continuous close contact with the body, such as at the armpits and belt line.
- Clothing plays a greater role in the transmission of body lice. Body lice survive longer off the host (4–10 days) than head lice; eggs also survive longer off the host (up to 30 days).
- Body lice are unlikely to become permanently established on a host who maintains good personal hygiene, including regular changes to clean clothing.

Crab lice (*Phthirus pubis*) are shorter (about $\frac{1}{16}$ inch long) than the other lice, are oval in shape, and have greatly enlarged second and third pairs of legs with large claws.

Other epidemiologic features are:

- Crab lice mainly infest pubic hair; they occasionally infest other coarse hair—axilla, eyelashes, eyebrows, mustache, or beard.
- Eggs are always attached to hair.
- Clothing plays an extremely small role in transmission. When separated from the human host, crab lice die in less than 24 hours.
- Transmission is almost always venereal; on occasion, indirect transmission occurs from clothing, bedding, and towels.

LEGAL BASIS FOR CONTROL OF LICE

Title 28, Health and Safety, Chapter 27, Communicable and Non-Communicable Diseases, Sections 27.71 (11), § 27.71 (12), 27.72, and 27.73 are the legal basis for excluding and readmitting children to school in relation to specified diseases and infectious conditions.

§ 27.71 (11) specifically relates to *Pediculosis humanis capitis* (head lice) and provides for exclusion of students from school (public, private, parochial, Sunday, or other school or college or preschool) who have been diagnosed by a physician or are suspected of having pediculosis by

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Most of the material included in this chapter came from:
Guidelines for a School Based Program for Control of Lice Infestation and Other Related Conditions. Rev. 1986, Reprinted 1999. Pennsylvania Department of Health. H514.028P. 29 pp.
Wisconsin's School Integrated Pest Management Manual, School Pilot Program Draft. March, 1999. 258 pp.

the school nurse. Exclusion from school is for the period of time until the student is judged noninfectious by the school nurse or by the child's physician.

§ 27.71 (12) requirements for body lice (*Pediculosis humanis corporis*) are identical to the requirements for head lice. Pupils are excluded from attending school until judged non-infectious by the nurse in school or by the child's physician.

§ 27.72 provides for exclusion from school of pupils showing symptoms judged noninfectious.

§ 27.73 provides for readmission to school if the nurse is satisfied that the live infestation is noncommunicable, or when the child presents a certificate of noninfectiousness from a physician.

The Pennsylvania Department of Health's Regulations of Communicable and Non-Communicable Disease do not include *Phthirus pubis* (crab lice).

CONTROL OPTIONS

When lice are discovered in a classroom, all children should be inspected for active lice. All members of the family of any child found with head lice also need to be checked for lice activity. Some school districts will adopt a "no nit" policy and not allow students back into the classroom with any nits remaining on the hair. Unless the problem is addressed at home, an infestation may recur.

Because of increased resistance to prescription and nonprescription treatments, head lice have become more difficult to manage, leading to more pressure on schools to provide treatments. *However, schools should not be sprayed to control head lice.*

Nonchemical Control

Treatments of the Classroom

- Vacuum furniture and floor rugs thoroughly. Discard the vacuum bag immediately.
- Clothing (coats, hats, and other items) can be isolated in individual plastic bags for each student.
- Dry clean or wash clothing in hot water and use a hot dryer setting to kill lice.

Personal treatments

- Because treatments do not kill 100 percent of the eggs, it is important to retreat within 7 to10 days for control. **It is important to read and follow the directions on any product used to control lice.**
- Nit combs are designed to remove lice and eggs from the hair and are very effective if used properly.
- The use of oils such as olive oil and coconut oil have shown promise if left on the hair for at least 8 hours. Consult with the school nurse or local public health nurse for more information.

Chemical Control

Chemicals should not be used within schools to control lice. Infestations result from personal contact or the sharing infested articles such as combs, brushes, and hats. School nursing staff can educate parents about proper louse management in the home.

PREVENTION

Prevention is always better than cure. Here are some suggestions that should help prevent an initial infestation of head lice:

- Assign hooks for coats in the cloakroom.
- Have students keep hats in coat sleeves or pockets rather than in piles on shelves or on the floor.
- Resting mats, towels, or pillows for younger children should be permanently assigned and kept separate while in use and in storage.
- Sharing of combs, brushes, or hats should be avoided.

If an infestation should occur, several steps can help prevent a reoccurrence.

- All personal articles that have been in contact with the patient's head should be deloused. Normal laundering with hot, soapy water (125°F for 10 minutes) or dry cleaning will kill lice and nits on clothing, bed linens, and towels.
- Combs and brushes should be soaked for 10 minutes in a pan of very hot water.
- Car seats, furniture, and carpeting touched by infested individuals should be vacuumed. Discard the vacuum bag immediately.
- Avoid close contact with individuals known to be infested.
- Avoid letting others use your personal articles, particularly hats, combs, and scarves.
- Bathe and shampoo frequently with hot water and soap. Many lice are killed or dislodged in the process.

For more information about head lice, contact the Pennsylvania Department of Health, P.O. Box 90, Health and Welfare Building, Harrisburg, PA 17108; call 1-877-PAHEALTH (877-72-432584); or call your district health consultant. Information also is available on the Pennsylvania Department of Health's Web site at **http://www.health.state.pa.us** and on the National Pediculosis Association site at **http://www.headlice.org/**.

IPM for Rodents in Schools

INTRODUCTION

Rats and mice often enter schools and warehouses in search of food and shelter. The most common rodent pests are the commensal rats and mice. These are Old World rodents that have adapted to live with humans. They include the roof rat, Norway rat, and house mouse. These commensal rodents have been carried by humans to every corner of the Earth. Rats and mice consume or contaminate large quantities of food and damage structures, stored clothing, and documents. They also serve as reservoirs or vectors of numerous diseases, such as rat bite fever, leptospirosis (Weil's disease), murine typhus, rickettsial pox, plague, trichinosis, typhoid, dysentery, salmonellosis, hymenolepis, tapeworms, and lymphocytic choriomeningitis (Mallis, 1997).

In most cases of rodent infestation, the pest animals can be managed without having to resort to the use of poisons. Practicing good sanitation and exclusion will prevent most problems. If rodents do find their way indoors, small populations can be easily eliminated with various nontoxic methods. Rodenticides (rodent baits) need only be used in cases of large or inaccessible infestations. Trapping rodent pests is often preferable to using baits. Traps prevent rodents from dying in inaccessible places and causing odor problems. Traps also can be used in situations where baits are not allowed.

RODENT ECOLOGY

The **house mouse** is the most common commensal rodent invading schools. It is primarily nocturnal and secretive. The presence of mice is usually indicated by sightings, damage caused by gnawing into food containers, or presence of droppings. In the wild, house mice feed primarily on seeds. In the school, they prefer grain products, bird seed, and dry pet food. They tend to nibble on many small meals each night. House mice are inquisitive and actively explore anything new. They also are good climbers. However, they have a small home range and usually stay within 10 to 30 feet of their nest. Nests usually are built in structural voids, undisturbed stored products or debris, or in outdoor burrows. Mice and rats are very nervous about moving in the open. The more cover they have, the more comfortable they are. They would rather run behind an object or along the baseboard of a wall than across an open space.

The **roof rat** or **black rat** is more commonly encountered in buildings in the south, but is sometimes found in Pennsylvania. These rats are excellent climbers and often nest in attics, wall voids, and hollow trees. They prefer to travel off the ground and enter houses from nearby trees or along power lines. Roof rats prefer fruit, but will eat any type of human, pet, or livestock food. Rats usually fear new items in their environment and avoid them for several days. This means that traps should be left in place for at least 1 week before they are moved to a new location. The presence of roof rats can be determined by gnawing damage, the presence of droppings, sightings, sounds of scratching, squeaking, or gnawing in walls or ceilings, and characteristic dark, greasy rub marks along frequented paths along walls and on rafters. Rats have large home ranges and may travel more than 50 yards to reach food or water. Concentrating traps along rat runways or favorite routes of travel is most effective.

Rats occupying buildings and sewers in Pennsylvania are generally **Norway rats**. These rats are strong burrowers, but can also climb well. They are excellent swimmers and can swim under water for up to 30 seconds. They can enter buildings by coming up toilet pipes. These rats usually dig burrows along building foundations and under debris piles. They have a strong preference for meat and fish, but will do well on any type of human or pet food. Raw or cooked meat and fish, especially sardines, are excellent baits, but peanut butter also works well. Like the roof rat, the Norway rat is cautious around new objects and has a very large home range, more than 50 yards in radius. The Norway rat is very aggressive and will drive roof rats out of an area. However, both species of rats may be found in the same building, with roof rats in the attic and Norway rats in the basement.

SANITATION AND EXCLUSION

Proper sanitation will do a great deal to manage rodent pests. All animals have three requirements for life: food, water, and cover. Removing any one of these will force an animal to leave. Removing debris, such as piles of waste lumber or trash, used feed sacks, and abandoned large appliances, will substantially reduce the harborages for rodent pests. Trim trees, vines, bushes, grass, and weeds at least 12 to 18 inches from all buildings to decrease cover for rodent runways and prevent hidden access to buildings.

Most of the information in this chapter was modified from Kern, W. H., Jr. and P. G. Koehler, *Nonchemical Rodent Control*. University of Florida School IPM Web site at **http://schoolipm.ifas.ufl.edu/tp9htm**. March 1998.

Stacked firewood stored for long periods provides good harborage for all three commensal rodents. Store pet food and seeds, such as wild bird seed, in rodent-proof glass or metal containers to eliminate rodent access to these food sources. Collect and remove fallen fruit from backyard trees and orchards. Keep lids on trash cans and close dumpsters at night to make an area less attractive to rats and mice. The drainage holes in dumpsters should be covered with hardware cloth to keep rodents out.

Exclusion is also called *rodent-proofing*. This involves making your structure a fortress that rodents cannot breach. Rodents can squeeze through any opening that their head can fit through. A ¼-inch opening can admit mice, and a ½-inch opening can give access to rats. Young rats and mice are the dispersing individuals, so these are the ones most likely to invade new areas, like schools. Any opening that a pencil can fit through will admit a mouse.

Below is a list of recommended materials for excluding rats and mice.

- Galvanized, stainless, or other non-rusting metal.
- Sheet metal, 24 gauge or heavier.
- Expanded metal, 28 gauge or heavier.
- Perforated metal, 24 gauge or heavier.
- Hardware cloth, 19 gauge or heavier, ¼-inch or smaller mesh.
- Cement mortar with a 1 part cement: 3 parts sand mix or richer.
- Concrete with a 1 part cement: 2 parts gravel: 4 parts sand mix or richer. Broken glass added to mortar or concrete will deter rodents from tunneling through a patched hole before the material hardens.
- Brick, concrete block, tile, or glass will exclude rodents if in good repair.
- Wood will exclude rodents if no gnawing edges are present.

TRAPS

There are four main types of rodent traps: snap traps, multicatch traps, single-catch live traps, and glue boards. (Some people consider live trapping the least humane method of killing rodents, claiming psychological stress on the animal. The most humane method of killing them would be rodenticides, followed by snap traps, glue boards, and live traps).

Snap traps include both the classic rodent traps with the wood base and the newer metal clothespin traps. They are designed to kill the trapped animal quickly and humanely. Snap traps should not be set where children or pets will come in contact with them. They have three different types of triggers: wood/prebaited, metal for holding bait, and expanded trigger, which is used in runways. The expanded trigger is the most versatile, since it also can be baited. Older snap traps with other types of triggers can be modified to produce an expanded trigger.

Traps should be placed where rodents are likely to be. Rodents are creatures of habit and prefer to follow the same runways they usually use. It is important to identify these runways and place traps there. Runways can be identified by sprinkling a fine layer of flour or baby powder in suspected areas and looking for tracks. This is a safe diagnostic method for determining rodent activity, but should not be confused with the use of rodenticide tracking powders, which require a restricted-use pesticide license. Rodents often run along edges, so traps should be set along walls, especially where objects such as a box or appliance will guide them into the trap. Traps for mice should be set 6 to 10 feet apart. Roof rats prefer to travel above the ground and are easier to trap along these precarious pathways than on the ground.

The type of bait used depends on the species of rodent pest. Peanut butter, pieces of fruit or nut meats are the best baits for roof rats. Peanut butter or gum drops stuck to the trigger or rolled oats or bird seed sprinkled on the trap are good baits for house mice. When food is abundant, nesting material, such as a cotton ball, tied to the trigger can act as an effective lure.

Multicatch traps are designed to repeatedly catch mice and reset themselves for another capture. These traps have the ability to capture several mice with one setting, and the scent from the captured mice entices others to the trap. However, these traps are expensive. Also, the captured mice are still alive and must be dealt with. Methods of dealing with the captive rodents include submerging the entire trap in a bucket of water and drowning them, using drowning attachments available for some traps, placing glue boards in the holding compartment of the trap, or finding someone with a pet snake that eats mice. Releasing captured rodents outside is not a solution, since they will quickly find a way back into the structure. Trap-wise rodents also are more difficult to trap than naive ones. Like any other trap, multicatch traps must be checked regularly to prevent the captured rodents from starving or dying of thirst and creating an odor problem. Available multicatch traps include the Kness "Ketch-All" Automatic Mouse Trap, the Victor Tin Cat Repeating Mouse Trap, and the "Mini-Mouser."

Single-catch live traps are rodent-sized cage traps of various styles. These traps capture the rat or mouse alive and unharmed, but you have to deal with the captured rodent. Rodents should not be released, because they will return to buildings. Rodents caught in these traps are best dispatched by submerging the entire trap in a bucket of water. These traps should be placed against walls or in runways. The most effective bait for mice with this type of trap is rolled oats (uncooked oatmeal) sprinkled inside the trap, with a fine trail leading out. Rat-sized live traps are produced by Havahart, Kness Manufacturing, Mustang Live-catch Traps, Safeguard Live Animal Traps, Sherman Live Traps, and Tomahawk Live Traps. Mouse-sized live traps are produced by Havahart, Sherman Live Traps, Tomahawk Live Traps, and Trap-Ease Mouse Live Trap.

Glue boards are used just like snap traps. While both rat- and mouse-sized glue boards are made, these traps are most effective against juvenile mice. Rats are often strong enough to pull themselves free from glue boards. Glue boards should not be set in wet or dusty areas, because these conditions render the traps ineffective. Wet feet and fur will not stick to the glue, and dust coats the glue until it is no longer sticky. These traps also should not be set where children or pets will come into contact with them. Glue boards are not hazardous to children or pets, but an encounter will create a frustrating mess. If that happens, clean up hands with room-temperature cooking oil and clean surfaces with paint thinner or mineral spirits. The best glue boards have at least a $\frac{1}{8}$- to $\frac{1}{4}$-inch layer of glue. Do not set glue boards near open flames or above carpets. Glue boards should be secured with a tack or small nail, wire, or double-sided tape if they are placed on ledges, pipes, or rafters over food preparation surfaces or carpets.

ULTRASOUND DEVICES

The principle behind ultrasonic devices is to create a loud noise above the range of human hearing (above 18 to 20 kHz) that is unpleasant to pest species. The problems with ultrasound devices are numerous. Animals can adapt to most situations, and in a short time they become accustomed to the sound. If the original attractant, such as food, is still present, the rodents will return. The short wavelengths of ultrasound are easily reflected, creating sound shadows. The rodents simply shift their activity to these low-noise shadows.

Ultrasonic devices will not drive rodents from structures if food, water, and shelter are available. However, they may have a part to play in rodent integrated pest management. Ultrasonic devices may increase trapping effectiveness by altering the normal movement patterns of individual rodents. Traps set in the sound-shadow areas will become more effective since the rodents will be concentrated in these areas. The high cost of the units must be weighed against the increase in trapping effectiveness to determine if they are cost-effective.

IPM for School Lawns

INTRODUCTION

School lawns often cover several acres and serve important roles as athletic fields, picnic lunch sites, outdoor classrooms, and general recreational areas for the community at large.

Heavy use of lawns and athletic fields causes stress that predisposes grass to attack by a variety of weeds, pest insects, pathogens, and vertebrates such as moles. As a result, most pesticides used on school grounds are applied to lawns and athletic fields.

Because the bodies of children and youths are often in direct contact with the grass, using pesticides on lawns increasingly raises concerns among parents and health professionals. On the other hand, coaches and school administrators are under pressure to ensure quality turf for use by students and by community athletic leagues. In addition, the competence of landscape maintenance staff is often judged by the aesthetic appearance of the lawns that surround most schools. These various viewpoints often come into conflict when pests threaten lawns and athletic fields.

The key to lawn IPM is regular scouting. Cultural practices that optimize growth of grasses and minimize conditions favorable to pest insects, weeds, or pathogens are vital to an IPM program. The following discussion describes how to implement an IPM approach to lawn care. Since specific methods for managing all possible lawn pests is beyond the scope of this chapter, a general IPM approach is described, followed by complete management programs for a typical lawn pest, chinch bugs.

DETECTION AND MONITORING

An IPM approach to lawn management begins with a monitoring program. Monitoring entails making *regular* inspections of the lawn to gather and record site-specific information on which to base pest management decisions. Monitoring enables pest managers to do the following:

- identify the pest(s)
- identify any natural enemies of the pest(s)
- apply preventive methods to reduce the occurrence of pest problems
- determine *if* any treatment is needed
- determine where, when, and what kind of treatments are needed
- evaluate and fine-tune treatments as the pest management program continues over the seasons

Tools Used to Monitor Lawns

The following tools are useful for monitoring lawns. They can be carried in a sturdy bag designed to transport baseball equipment (available at most sporting goods stores). The soil probe with its extension fits snugly in the bottom pocket designed for baseball bats, and everything else fits into an upper zippered area.

- soil probe
- pH meter
- soil thermometer
- 10X hand lens (magnifying glass)
- watering can and bottle of detergent
- plastic bags for collecting specimens
- clip board and forms for recording data
- a ball of twine or clothesline for taking transects
- a small hand trowel and knife
- camera
- field guides for identifying pests and natural enemies (*Turfgrass Insect and Mite Manual*, by Shelton, Heller, and Irish, 1983)
- pheromone traps for cutworms, sod webworms, and other pests

Background Information on Local Pests

When beginning a monitoring program, some effort should be made to become familiar with the common pest insects, weeds, and lawn pathogens in the local area. Learn about their life cycles and how to recognize them. Table 6 on page 64 lists common lawn pests in Pennsylvania along with Web sites that provide more information about each. Additional information can be obtained from the Penn State Cooperative Extension office in your county. It also is important to learn to recognize the natural enemies of common lawn pests and factor their presence into deciding if treatments are needed and which ones to use.

Most of the information for this chapter was modified from:
IPM for Schools: A How-to Manual. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.
Additional chinch bug information is from: Hoover, G. A. *Chinch bugs*. The Pennsylvania State University. Entomology-Turf-2. 1992.

TABLE 6.

Common Pennsylvania Turf Pests and Web Sites

Common Name	Scientific Name	Web sites for more information
General Pest Information		http://www.ces.ncsu.edu/TurfFiles/pubs/insects/mip-doc.html
Ant, Nuisance	*Formicidae* spp.	http://www.ento.psu.edu/extension/factsheets/ants_in_lawns.htm
Black Cutworm	*Agrotis ipsilon*	http://ianrwww.unl.edu/ianr/entomol/turfent/documnts/cutworms.htm
Bluegrass Billbug	*Sphenophorus* spp.	http://www.ag.ohio-state.edu/~ohioline/hyg-fact/2000/2502.htm
Hairy Chinch Bug	*Blissus leucopterus hirtus*	http://www.ag.ohio-state.edu/~ohioline/hyg-fact/2000/2027.html
Sod Webworm	*Crambinae* spp.	http://www.ag.ohio-state.edu/~ohioline/hyg-fact/2000/2011.html
White Grub Complex	Scarabaeidae	http://www.ag.ohio-state.edu/~ohioline/hyg-fact/2000/2510.htm http://www.ento.psu.edu/extension/factsheets/white_grubs.htm
Asiatic Garden Beetle	*Maldera castanea*	http://ctr.uvm.edu/ctr/el/el247.htm
Black Turfgrass Ataenius	*Ataenius spretulus*	http://128.8.190.44/umturf/Insects/Black_Turfgrass_Ataenius.html
European Chafer	*Rhizotrogus majalis*	http://ctr.uvm.edu/ctr/el/el199.htm
Green June Beetle	*Cotinus nitida*	http://www.aces.edu/department/extcomm/publications/anr/anr-991/anr-991.htm
Japanese Beetle	*Popillia japonica*	http://www.ag.ohio-state.edu/~ohioline/hyg-fact/2000/2001.html
Northern Masked Chafer	*Cycolcephala* spp.	http://www.ag.ohio-state.edu/~ohioline/hyg-fact/2000/2505.html
Oriental Beetle	*Exomala orientalis*	http://www.ces.ncsu.edu/TurfFiles/pubs/insects/mip-doc.html
May/June Beetle	*Phillophaga* spp.	http://iaa.umd.edu/umturf/umturf.html

Gathering Background Data on the Site

The next step in a monitoring program is to map all lawn areas, noting locations of existing pest problems or conditions that can produce pest problems, such as bare spots or broken sprinkler heads. Identify the lawn grasses in each area and record the maintenance history of the turf and current horticultural practices. Soil should be tested at representative sites to assess fertility status and requirements. If any pest organisms are present, be sure to get an accurate identification. Many unnecessary pesticide applications can be traced to mistaken identification of pests.

Next, give each major section of lawn an identifying number. Prepare a monitoring form for recording ongoing maintenance activities and information about pests and their management in each section.

You will need to compile an inventory of existing lawn maintenance equipment. In addition to mowers, do you have an aerator, dethatcher, and fertilizer spreader that can handle organic materials? Is there a spring-tooth harrow for removing weeds from infields and running tracks? These are useful tools in nonchemical lawn management. Inspect the condition of the equipment, too. Are mower blades kept sharp? Can mowing height be adjusted easily? Does the equipment have flotation tires to reduce soil compaction? Prepare a list of equipment needs so they can be worked into the budget process.

Developing Pest Tolerance Levels

Most lawns can tolerate some pest presence without compromising appearance or function. The challenge for the pest manager is to determine how much damage is tolerable and when action is needed to keep pest damage within tolerable levels. Since the users of the lawn must be taken into account when deciding whether or not treatments are warranted, it is a good practice to involve representatives of these interest groups in setting pest tolerance levels for lawn areas.

One approach is to work with an IPM advisory committee to develop pest tolerance levels for lawns at each school site. Tolerance levels will differ depending on location and uses of the lawns. For example, tolerance for pest presence on lawns at the front of the school in public view may be lower than tolerance for playing fields behind school buildings. Tolerance levels may also differ depending on the particular pest. For example, tolerance for damage by pest insects or pathogens that can kill large areas of turf, leaving bare soil, may be lower than tolerance for weeds that displace grasses but nevertheless continue to cover soil and serve as a playing surface.

Tolerance levels can be quantified in a number of ways. The Transect Method for Monitoring Weeds in a Lawn, discussed on page 66, describes a method for quantifying the amount of weeds growing in a lawn. This permits expression of tolerance levels by percentage of weeds. For example, "Up to 25 percent weed growth is tolerable on the back lawn at the elementary school; only 10 percent is tolerable on the football field at the high school."

Tolerance for insect damage can be correlated with numbers of insects present and amount of visible damage. For example, white grubs can be monitored by examining several areas of soil underneath the grass. A spade is used to cut three sides of a 1-foot square of grass. The grass is carefully folded back, using the uncut edge as a hinge. Soil from the roots is removed, and the number of exposed grubs is counted. Then the grass can be folded back into place, tamped, and watered in. In well-managed lawns, depending on the species, up to 15 grubs per square foot can be present without causing any appreciable damage to the turf. In stressed or poorly managed lawns, however, 15 grubs per square foot might seriously damage the grass.

By setting tolerance levels, pest managers and groundskeepers can gear their management efforts to keeping pest populations within tolerable levels, and apply treatments only if, when, and where necessary. Involving members of the school and community in setting treatment guidelines can minimize confrontations and help develop broad support for the IPM program.

Evaluating Pest Management Practices

When actions are taken to reduce pest presence, monitoring data should be used to evaluate the effectiveness of the treatment. Did pest numbers go down sufficiently to prevent intolerable damage? Were treatments cost-effective? Is the problem likely to recur? Can conditions causing chronic pest problems be altered or removed? If not, can other ground covers better suited to site conditions replace the lawn?

MANAGEMENT OPTIONS

When pest numbers threaten to exceed tolerance levels (in other words, when the action level is reached), a wide variety of strategies and tactics is available to solve any lawn pest problem. The first approach is to address conditions causing stress to lawns.

Stress and Pests

The pest problem of greatest concern on school lawns—and the target of highest pesticide use—is the growth of weeds, such as dandelions (*Taraxacum officinale*) or crabgrass (*Digitaria* spp.). Presence of weeds is a symptom of a lawn undergoing stress or poor management, a common occurrence on school lawns and athletic fields. Lawn stress can contribute to the development of insect and disease problems as well.

Sources of stress include levels of use unsuited to the grass species that has been planted, compacted soils, improper mowing heights, too much or too little irrigation or fertilization, accumulation of thatch, and uneven grading.

Knowing the identity of the pest and something about its biology often reveals the specific source of stress. Relieving the stress can reduce or eliminate the pest problem. For example, the weed yellow nutsedge (*Cyperus esculentus*) often grows in waterlogged soils, so its presence could indicate a faulty or broken irrigation valve or a low spot in the lawn. The presence of chinch bug (*Blissus* spp.) damage, on the other hand, indicates drought stress. Brown patch disease, caused by the fungus *Rhizoctonia solani*, suggests excessive fertilization with soluble nitrate or slow-release fertilizers, especially during hot, wet conditions.

The Transect Method for Monitoring Weeds in a Lawn

1. At the beginning and at the end of the season, establish three parallel transect lines along the length of the field. Use the center of the field and two imaginary lines on either side.

   Note: Three transects will give sufficient data to indicate the percentage of weed cover in the total turf area. If time is limited, information recorded from one transect across a representative area of turf (for instance, down the center of the field) may give sufficient indication of weed trends for management purposes.

2. Calculate the number of paces you will walk between samples.
   a. Measure the length of one of your transect lines in feet (e.g., 360 feet).
   b. Measure the length of the pace of the person doing the transect. To do this, slowly walk a known length (e.g., 20 feet), count the number of paces it takes to cover this distance (e.g., 10 paces), and divide the distance by the number of paces (20 feet ÷ 10 paces = 2 feet per pace). This figure represents the average length of the pace.
   c. Divide the length of the field by the length of the pace (360 feet ÷ 2 feet per pace = 180 paces). This establishes the number of paces it takes to walk the transect.
   d. Divide the number of paces by the number of samples to be recorded (a minimum of 20 samples is recommended): 180 paces ÷ 20 samples = 9 paces per sample. Thus, in this example, a sample will be taken every 9th pace along the transect.

3. Stretch lines of string along the three transect lines, laying the string directly on the ground.

4. Beginning at one end of the first transect, walk the calculated number of paces (9 paces in the above example), stop and look at a 3-by-3-inch area (this is about the circumference of a softball or the lid to a 1-pound coffee can) immediately in front of your toe.

   If this area contains part or all of a weed, check the 'yes' box on the first line under 'Transect A' on the monitoring form (see Figure). If you know the identity of the weed, write it down.

   If the toe sample area contains grass, check the 'no' box on the monitoring form. If 25 percent or more of the toe area sample is bare soil, check the box marked 'bare.' If less than 25 percent is bare, but a weed is present, check 'yes.'

   Continue pacing the transect line and marking the monitoring form. Repeat along the two other transect lines.

5. To calculate the average percentage of weeds, total the number of boxes marked 'yes' in each column and multiply by 100. Divide this number by the total boxes in all columns. The resulting figure represents average percent weed cover in the turf. Do the same calculation with the boxes representing bare ground. This will indicate percent area that will become weedy if not seeded to grass.

6. By collecting data from the transects at the beginning and end of each season, the turf manager can spot emerging problem areas. For example, if several boxes in succession are marked 'yes,' indicating weed presence, a closer look at this area on the transect is warranted. Usually such 'clumping' of weed growth indicates exceptionally heavy wear on the turf, although structural problems, such as severely compacted soil, a broken irrigation line, inoperative sprinkler head, or scalping of the turf due to uneven grade, also may be indicated.

   By monitoring the turf area from season to season, the manager can tell if weed populations are rising, falling, or remaining relatively stable. This information will indicate whether or not current turf management practices are keeping weeds at or below the agreed-upon tolerance level. If weed populations are rising, changes in management practices are indicated.

Weed Monitoring Form for Turf

Location of Turf _____ Date _____
Data collected by _____ Length of pace _____
Distance between sampling points on transect _____
(for example, every nine paces)
Number of transects _____ Length of transects _____
Sketch of location of transects

	Transect A				Transect B				Transect C			
	Yes	No	Bare	Weed ID	Yes	No	Bare	Weed ID	Yes	No	Bare	Weed ID
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												

Average % weed growth _____ Average % bare area _____

Total the number of boxes marked 'Yes' in each column. Multiply this number by 100 and divide by 60 (the number of samples taken). The result is the average percentage of weeds growing in the turf area. Follow the same procedure to calculate percentage of bare area.

Reducing Stress on Lawns

The best way to reduce stress on lawns is to use good horticultural practices during lawn installation and maintenance. Even where budgets are limited, key sources of stress can be avoided or diminished by minor changes in maintenance practices, such as raising the mowing height or changing fertilizer formulations. The following lawn care suggestions will help keep pest problems to a minimum.

Maintaining Healthy Soil

The most vigorous lawn growth occurs in loose, loamy soils teeming with beneficial microorganisms, insects, worms, and other organisms. These organisms play critical roles in transforming thatch and grass clippings into humus. Humus slowly releases nutrients and buffers grass roots from extremes of drought or other stresses. Soil organisms also play an important role in biological pest management. For example, certain beneficial microorganisms protect lawn roots from attack by soil pathogens or insects such as white grubs.

The presence of humus in the soil is key to a healthy soil ecosystem. One way to improve poor soils and maintain healthy soils is to ensure that organic matter is routinely replenished by leaving grass clippings to decompose, and fertilizing or topdressing with organic materials such as sludge or composted manure. To prevent buildup of an organic layer, the organic material can be incorporated into the soil using an aerator equipped with hollow tines and a heavy drag mat attached. This operation is best performed during cool, moist seasons when grass is actively growing. On smaller areas, a grass rake can be used to incorporate the materials.

Planting Appropriate Grass Species

School lawns are subject to high levels of use and wear, and maintenance budgets are usually low, so it is important to select blends of grass species tolerant to such conditions and resistant to local pest problems. The Penn State Cooperative Extension office in your county can recommend grass species suited to local climate and conditions. In Pennsylvania, tall fescue (*Festuca arundinacea*) is recommended for school situations.

Reducing Soil Compaction

When lawns are heavily used, or simply mowed on a regular basis, the soil eventually becomes compacted, and the pore spaces that allow water and air to pass through the soil become compressed, creating adverse conditions for root growth. Compaction can be reduced through core aeration and amending soils with organic matter.

Core aeration involves removing plugs of grass to improve air exchange and water penetration into the soil. Ideally, heavily used turf should be aerated at least two times per year, although even a single aeration is better than none.

After aeration, and before seeding the desired lawn grass, drag the lawn with a heavy drag mat to break up cores of soil left by the aerator and to fill in holes.

Mowers and other maintenance equipment compact the soil. By rotating the point of mower entry onto the lawn from week to week, compaction at entry points can be minimized.

Increasing the Mowing Height

Most temperate grasses used on school lawns (tall fescues, perennial ryes, bluegrasses, and others) can be mowed at a height of 2½ to 3 inches without sacrificing vigor or function as ball fields or recreational areas. The taller the grass can be kept and the denser the canopy, the greater the interception of available sunlight. Because taller grass shades the soil, weed seeds are less likely to germinate.

Adjust mowing frequency to changes in the growing season. Weekly intervals may be appropriate when grasses are growing vigorously, but when grasses are semidormant, 14 days or longer may be more appropriate. The right interval between mowings allows grasses to recover from the previous cut.

Careful Irrigation

Too much or too little water stimulates pest problems. For example, many lawn diseases result from excessive irrigation. Development of a disease can often be arrested by letting the lawn dry out, then keeping irrigation to a minimum. On the other hand, chinch bugs require hot dry conditions for optimal survival and reproduction. Irrigation during the spring and early summer may increase the incidence of pathogen spread, especially the lethal fungus, *Beauveria* spp. The adults can withstand water because of the protective hairs on the body but the nymphs readily get wet and can be damaged by large water droplets.

The length of time needed to adequately water lawns is determined by the time it takes to wet it to the depth of the root system. Most lawn grass roots extend 4 to 6 inches in the soil, but because grasses and soil conditions differ, irrigation schedules must be tailored to individual lawns and adjusted for seasonal changes. Infrequent, deep irrigation is best, since frequent, shallow watering promotes shallow rooting. Use a soil probe or a pointed tool, such as a screwdriver, to determine when soil is wet 4 to 6 inches below the soil. This will indicate how long to leave sprinklers on at each irrigation.

Irrigation equipment should be checked to ensure that it is in good repair and that all areas of the lawn receive adequate coverage. Low spots should be leveled or drained to avoid waterlogged soils that favor weeds and pathogens.

Keeping Thatch to a Minimum

Thatch is the accumulation of dead but undecomposed roots and stems that collect in a layer at the soil surface. If the thatch becomes excessively deep—greater than ½ inch—water and nutrients do not penetrate the soil adequately. When water puddles on thatch, it enhances the habitat for disease organisms. Regular aeration keeps thatch at an acceptable level. Excessive nitrogen applications may result in organic matter production rates that exceed breakdown, encouraging thatch accumulation. Excessive layers of thatch can be removed with dethatching rakes, or with power dethatchers available from equipment rental companies. It is wise to seed the area with desired grasses wherever lawns are thinned by dethatching procedures.

Fertilizing with Restraint

Excessive nitrogen fertilizer produces weak grass that is susceptible to disease attack. A soil test should be obtained before planning annual fertilization programs. Only the levels of nutrients needed should be applied. Split applications (one in spring, one in fall) should be used, rather than a heavy single application in the spring. Use slow-release fertilizer to prolong the availability of nutrients throughout the growing season.

Fertilization can be used to directly suppress weeds and lawn pathogens. A study by Ohio State University Extension Service researchers in the 1940s showed that an application of 20 pounds of composted poultry manure per 1,000 square feet of lawn in late fall and early spring stimulated early spring growth of lawn grasses, enabling them to crowd out crabgrass. In this study, crabgrass was reduced by up to 75 percent within one year.

Direct Pest Suppression

When the horticultural methods listed above are not sufficient to solve the pest problem, direct suppression methods, including physical, biological, and chemical tactics, can be integrated into the program.

Physical controls include using a flamer to spot-treat weeds, or using a bamboo pole to flick off dew from grass blades in the early morning to deny nourishment to lawn pathogens. Biological controls include applying microscopic, insect-attacking nematodes to kill soil-dwelling white grubs, or topdressing lawns with microbially enhanced soil amendments to kill lawn pathogens.

Chemical controls are available. Check with the Penn State Cooperative Extension office in your county for information about pesticides appropriate for your pest problems.

IPM Program for Hairy Chinch Bugs

Hairy chinch bugs *(Blissus leucopterus hirtus)* are the most important of the "true bugs" (order Hemiptera) that become pests on lawns. Heavily infested areas may contain as many as 200 to 300 chinch bugs per square foot.

IDENTIFICATION AND BIOLOGY

Adult chinch bugs overwinter in dry grass and other debris that offers them protection. In spring or early summer, depending on temperature and moisture, overwintering females lay from 200 to 300 eggs on leaves of grass, or push them into soft soil and other protected places. Young nymphs (the immature stages) emerging from the eggs are bright red with a distinct white band across the back. The red changes to orange, orange-brown, and then to black as the nymph goes through five growth stages in 30 to 40 days.

Nymphs range from about $\frac{1}{20}$ inch soon after hatching to nearly the size of the ¼-inch-long adult. The nymphs mature into adults, which are black with a white spot on the back between the wing pads.

DAMAGE

Chinch bugs suck the juices from grass leaves with their needle-like mouthparts. They also inject a toxic saliva into the plant that disrupts the plant's water-conducting system, causing it to wilt and die. Most damage is caused by nymphs and adults concentrated in limited areas and feeding on the same plants until all the available juice has been extracted from the grass. This feeding pattern results in circular patches of damaged grass that turn yellow and then brown as they die. In the yellow stage, the grass superficially resembles grass that is drought-stressed. As it dies, the chinch bugs work outward from the center of the infestation, destroying a larger area as they advance.

Populations of chinch bugs increase under hot, dry conditions. In wet, cool years, or when lawns are kept properly irrigated and not overfertilized, chinch bug populations decrease significantly because the moisture encourages the growth of the lethal fungus, *Beauveria* spp., a pathogen of chinch bugs.

DETECTION AND MONITORING

Lawns can be protected from damage by chinch bugs through regular monitoring. The objective is to detect pests while their populations are still small and determine whether their natural controls—such as adverse weather, other insects, and diseases—will keep the population low enough to prevent damage.

Any lawn can tolerate a low population of chinch bugs and most other pests without sustaining significant damage. If the monitoring techniques described below indicate that there are fewer than 10 to 15 chinch bugs per square foot, generally no action is needed.

It is a good idea to begin monitoring as early as mid-May, before overwintering adults have finished laying their spring eggs. A quick check of the lawn once a month until September should be sufficient in most areas.

Since nymphs tend to congregate in groups, it is important to check several areas of the lawn. Infestations often begin on the edges of lawns, particularly in sunny, dry spots, so check these areas carefully. Spread the grass apart with your hands and search the soil surface for reddish nymphs or black adults. Chinch bugs may also be seen on the tips of grass blades, where they climb during the day. Be certain to distinguish between the chinch bugs and their predator, the big-eyed bug, which they superficially resemble.

A second detection method requires a metal container (such as a coffee can) with both ends removed. Insert this can into the ground and fill it three-quarters full with water. Stir the duff at the bottom of the container. Count the number of adults and nymphs floating to the surface over a period of 10 minutes. Repeat this procedure in 3 to 5 locations in the lawn where damage is present, or in adjacent areas.

MANAGEMENT OPTIONS

Physical Controls

Chinch Bug-Resistant Grass Cultivars

If chinch bugs are a chronic problem, it may be advisable to replace existing grass with a type that is resistant to chinch bugs. Endophytic enhanced grasses may be used to repel insect pests. An endophyte is a fungus that grows inside a plant, and research has shown that turfgrass species containing endophytes have enhanced resistance to surface feeding insects, including chinch bugs, sod webworms and bill bugs. Try perennial ryegrass varieties such as Repell or Score, or a Kentucky bluegrass variety such as Baron.

Habitat Management

Chinch bugs are attracted to lawns that have an excessive buildup of thatch, are insufficiently irrigated (often due to soil compaction), or have either too little or too much nitrogen. The discussion of good lawn culture provided at the beginning of this section includes suggestions on overcoming these problems. Proper habitat management will go a long way toward suppressing these bugs.

Manual Removal

Small populations of chinch bugs can be removed from the lawn using the soap solution and white flannel cloth method described below. This is particularly appropriate when damage is just beginning to appear, since at this stage chinch bug nymphs are still congregated in specific locations and can be collected efficiently. Small vacuums also may be helpful.

Biological Controls

One of the primary tactics for the biological control of chinch bugs is conserving its natural enemies. At least two beneficial organisms often move in to feed on chinch bugs: the big-eyed bug and a tiny wasp. The big-eyed bug (*Geocoris* spp.) superficially resembles a chinch bug, so pest managers must learn to distinguish between the two. According to Ohio State University turf specialist Harry Niemczyk, "the body of the chinch bug is narrow, the head small, pointed, triangular-shaped, with small eyes, while the body of the big-eyed bug is wider, the head larger, blunt, with two large prominent eyes. Big-eyed bugs run quickly over the turf surface and are much more active insects than the slower-moving chinch bugs." (Niemczyk, 1981).

Although big-eyed bugs cannot be purchased from insectaries at this writing, recent research indicates that members of this genus can be reared easily and inexpensively, so they may become commercially available in the near future.

Soap-and-Flannel-Trap Method for Chinch Bugs

Put 1 fluid ounce of dishwashing soap in a 2-gallon sprinkling can and drench a 2-square-foot area of lawn where you suspect there are chinch bugs. Watch the area for 2 or 3 minutes. Larger areas can be covered by putting the detergent in a hose attachment designed to hold pesticides for spraying the lawn. If chinch bugs are present, they will crawl to the surface of the grass.

Next, lay a piece of white cloth, such as an old bedsheet or a piece of white flannel, over the area treated with the soapy water. Wait 15 to 20 minutes, then look under the cloth to see if chinch bugs have crawled onto it as they attempt to escape the soap. Their feet tend to get caught in the flannel's nap. Pick up the cloth and either vacuum it or rinse it off in a bucket of soapy water to remove the bugs. The vacuum bag should be disposed of so that the bugs will not return to the lawn.

This method can also be used to monitor for other insects such as lawn caterpillars, mole crickets, and beneficial insects that feed above the soil, but it will not bring soil-inhabiting grubs or pillbugs to the surface.

Chemical Controls

If nonchemical methods alone prove insufficient to solve the problem, then integrating a pesticide into your management program may be warranted. **Pennsylvania law allows pesticide applications on school grounds only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator.**

If pesticide use seems necessary to bring a serious chinch bug infestation under control, insecticidal soap or pyrethrin should be considered.

IPM for Silverfish, Firebrats, and Booklice in Schools

INTRODUCTION

Silverfish, firebrats, and booklice are discussed together here because they occur in the same or similar habitats. They prefer dark, moist environments with a supply of starchy foods or molds. Although they are all found in similar environments, silverfish and firebrats are not closely related to booklice. These nuisance pests can feed on wallpaper pastes, natural textiles, books, and manuscripts. They also feed on molds growing on various surfaces.

Silverfish, firebrats, and booklice can live both indoors and outdoors. They are frequently introduced into a building with boxes of materials that have been stored in damp basements or attics, but they also can wander in from the outside. Silverfish and firebrats are fast-moving and can travel throughout buildings. Once these insects find a good source of food, however, they stay close to it. In general, they cause little damage, but may cause people to take radical action based on their fear of insects.

SILVERFISH AND FIREBRATS

Identification and Biology

Silverfish and firebrats belong to an insect order called Thysanura. Insects in this order characteristically have three long, tail-like appendages about as long as the body. These insects are wingless, with chewing mouth parts, long antennae, and a body covered with scales. The mouthparts of silverfish and firebrats are used for biting off small particles or for scraping at surfaces. The most common species inhabiting buildings are in the genera *Lepisma* (silverfish) and *Thermobia* (firebrat). The silverfish (*Lepisma saccharina*) is about ½ inch long when fully grown and covered with silvery scales. It is grayish to greenish in color and its body has a flattened-carrot shape. The firebrat (*Thermobia domestica*) has a mottled appearance with patches of white and black, and is shaped like the silverfish.

Silverfish and firebrats eat material high in protein, sugar, or starch, including cereals, moist wheat flour, starch in book bindings, sizing in paper, and paper under which there is glue or paste. These insects often attack wallpaper, eating irregular holes through the paper to get at the paste. Silverfish may bite very small holes in various fabrics, including cotton, linen (they can digest cellulose to some extent), and silk. Firebrats will feed extensively on rayon, whereas silverfish usually damage it only slightly.

Characteristics of the silverfish:

- lays eggs in any season, usually in secluded places
- has a 3- to 4-month life cycle from egg to adult
- prefers moist areas (75 to 97 percent humidity) and moderate temperatures (70° to 80°F)
- is active at night or in dark places, and is rarely seen unless disturbed during cleaning
- may be found throughout the building—sometimes in boxes and books, or in glass utensils and sinks they have fallen into
- leaves yellowish stains on fabric
- outdoors, lives in nests of insects, birds (especially pigeons), and mammals, and under the bark of trees

Characteristics of the firebrat:

- lays eggs in cracks and crevices
- has a 2- to 4-month life cycle from egg to adult
- prefers moist areas with temperatures above 90°F
- is active at night or in dark places
- found where heat and starches are present (for example, in bakeries); also found in furnace rooms, steam pipe tunnels, and partition walls of water heater rooms

BOOKLICE (PSOCIDS)

The most common booklouse (*Liposcelis* spp.) is a small, grayish, soft-bodied insect with chewing mouthparts and long antennae. It is flat and superficially resembles the shape of the head louse. The common house-dwelling booklouse is wingless. The size of an adult is approximately 1/25 to 1/12 inch. Because they feed chiefly on mold, booklice cause little direct damage to plants and wood. They are commonly found in confined areas like the bindings of books, where they eat the starch sizing in the bindings and along the edges of pages.

Most of the information in this chapter was modified from:
Powell, T.E. *IPM for Silverfish, Firebrats, and Booklice in Schools*. University of Florida School IPM Web site at **http://schoolipm.ifas.ufl.edu/tp12.htm**. May 1998.
Jacobs, S. B. *Booklice*. The Pennsylvania State University. Entomology-NP-2. 1998.
Jacobs, S. B. *Silverfish*. The Pennsylvania State University. Entomology-SP-3. 1998.

Characteristics of the booklouse:

- has a life cycle from egg to adult lasting about 110 days
- prefers warm, moist conditions that are conducive to the growth of mold and mildew and require humidity of at least 60 percent
- found in books and paper products
- sometimes found on houseplants, where they may be feeding on honeydew (a protein-rich substance excreted by plant-eating insects such as aphids), or more likely, on the sooty mold that grows on the honeydew

DETECTION

Silverfish are found in bookcases, on closet shelves, behind baseboards, and in wallpaper, window or door frames, wall voids, attics, and subfloor areas. They prefer bathrooms and kitchens because of the moisture. Firebrats will be found in similar but warmer areas. Both silverfish and firebrats molt as many as 50 times during their life, so the appearance of cast skins can be used to detect their presence. Booklice prefer damp and warm habitats, so they are most numerous during the spring and summer. New buildings are not immune to booklice infestation.

If you suspect that damage to books, carpets, curtains, or other materials is due to silverfish or firebrats, confirm your suspicions using the following test:

- Mix flour and water to the consistency of house paint.
- Coat one or more 3-by-5-inch index cards with the paste.
- Let the cards dry, and place them where you have spotted the damage.
- If silverfish or firebrats are in the vicinity, they will be attracted to the card and will feed on the paste. Characteristic feeding marks appear as minute scrapings in irregular patterns. In addition, the edge of the card may be notched.

If you see groups of small, whitish insects in damp areas, suspect booklice, particularly if mold is present or the area smells moldy. Remember that booklice are considerably smaller than silverfish, and lack the telltale three long bristles at their hind end.

Silverfish, firebrats, and booklice also can be detected by placing sticky cockroach traps in the area where damage is occurring. When the insects are caught, they should be preserved in alcohol for professional identification.

MANAGEMENT OPTIONS

Physical Control

Dehumidifying

Booklice, silverfish, and firebrats are living indicators of excessive moisture. If the moisture is not eliminated, it may bring more serious problems, such as termites, carpenter ants, and wood rot.

Dehumidifying reduces the moisture content of the air. Some methods for dehumidifying an area include:

- Mending leaking pipes.
- Ventilating closed rooms and attics.
- Eliminating standing water.
- Using a dehumidifier.
- Replacing any single-glazed windows that repeatedly accumulate condensation with double-glazed windows.
- Using anhydrous calcium carbonate or silica gel to absorb free moisture. Do not use these agents in areas open to children.

Drying Stored Articles

Periodic airing and drying of articles stored in damp areas may help reduce the mold on which booklice feed. Disposing of moldy articles is often the simplest way of removing an infestation in an area.

Chemical Control

If nonchemical methods alone do not solve the problem, then integrating a pesticide into your management program may be warranted. Pesticides must be used in accordance with their EPA-approved label directions. Some insecticides are registered for managing silverfish and firebrats and/or booklice indoors, whereas others are registered for outdoor use only. **Pennsylvania law allows pesticide applications in schools only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator. The law also mandates a 7-hour reentry period for common access areas whenever pesticides are applied.**

Diatomaceous earth, borate-based insecticidal dust products, and silica aerogel can be used to kill these insects. Diatomaceous earth and borate-based products must be kept dry to be most effective.

Dusts should be applied only in cracks and crevices, crawl spaces, and other areas that are relatively inaccessible to humans and pets. Wear a dust mask or professional-quality respirator to provide proper lung protection when applying any dust.

Some baits for ants, crickets, and roaches are also labeled for silverfish and may be useful in some situations.

Residual sprays are labeled for silverfish and firebrats and can be applied where the pests are most commonly seen.

Products commonly found in schools, such as bleach, ammonia, and salt, can be mixed with water and used to kill molds on surfaces where booklice feed.

IPM for Spiders in Schools

INTRODUCTION

Despite their small size, spiders have evoked fear and revulsion in humans throughout history. Nursery rhymes and horror films malign them, but fears about spiders are largely unwarranted since most spiders are too small or have venom too weak to harm humans. In fact, they provide a great benefit to mankind by consuming vast numbers of insects in and around our homes and schools.

Spiders have 8 legs and 2 body regions, the cephalothorax (a head joined with a thorax) and abdomen. They lack wings and antennae. Almost all spiders have fangs and venom, but only a few are considered dangerous to humans, so it is important to be able to differentiate between relatively harmless spiders and those that should be avoided and/or controlled.

The species of spider that causes the most concern in the home or school environment in Pennsylvania is the black widow spider. Since there have been reports of the brown recluse spider being found in Pennsylvania, some information concerning it will be included. Both of these spiders are potentially dangerous to humans, and their bites may cause severe reactions or even death. However, these spiders usually will bite only if provoked, and then only under certain circumstances.

Other spiders that may produce painful bites or be of health importance may be grouped as:

1. Active hunters: some wolf spiders, jumping spiders and sac spiders.
2. Web builders: some cobweb spiders and funnel weavers (Mallis, 1997).

It is prudent to use caution when handling any larger spiders, even though most are harmless. Generally, spiders are not aggressive. Most bites occur when a spider accidentally becomes trapped against the skin or when a person picks it up.

REMOVING A RELATIVELY HARMLESS SPIDER

Most spiders found in and around a school can be used as an educational opportunity to teach some interesting facts about these fascinating creatures. If any spider found in the classroom creates anxiety on the part of the teacher or children, and the teacher wishes to remove it, invert a container of some sort over the spider, slide a stiff piece of paper over the mouth of the container, and then release the spider outside.

GENERAL SPIDER MANAGEMENT

You can manage the number of spiders in an area by reducing their food supply. If flies are getting in, screens should be installed or repaired. Security lighting may attract insects at night, and spiders feed on them, so outside lighting should not be placed directly over a doorway. Insects also may be attracted to poorly stored food or mishandled organic wastes. Eliminating the food source for these insects will reduce the food source for the spiders.

Removing debris and excess clutter also will reduce the number of harborage sites available. Debris and stacks of wood, pallets, blocks, and similar materials should be moved a distance from schools and elevated off the ground as much as possible. Vegetation should be removed from the sides of buildings and grass should be kept mown. For spiders already in residence, removing their webs and egg sacs discourages subsequent infestation. In most cases, vacuuming and reducing the spiders' food source will be sufficient to manage the problem.

The two potentially dangerous spiders—the black widow and the brown recluse—nest in undisturbed areas, often near the floor; therefore, thorough vacuuming in these areas from time to time also can help in their control.

A wide variety of chemicals are available for the control of spiders. **Pennsylvania law allows pesticide applications in schools only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator. The law also mandates a 7-hour reentry period for common access areas whenever pesticides are applied.** Misapplied chemical treatments may cause more harm than the real or perceived threat from spiders. Crack and crevice treatments may be necessary for the hunting spiders.

Black Widow Spiders

IDENTIFICATION AND BIOLOGY

There are several species of widow spiders in the United States, but the black widow (*Latrodectus mactans*) is the only native species found in Pennsylvania.

The adult female black widow is normally a shiny, jet-black spider about ½ inch in body length. With legs extended, the female measures about 1½ inches long. The female has the well-known reddish hourglass marking on

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Most of the information in this chapter is from:
IPM for Schools: A How-to Manual. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.
Green, S. G., and C. W. Rutschky. *Poisonous Spiders*. The Pennsylvania State University. Entomology-Public Health 85-1.

Illustrations on pages 74–76, by Cristol Gregory.

the underside of her abdomen. Because their webs are near the ground and the spiders hang upside down in the web, their distinctive marking is readily apparent. The adult male, which is not dangerous, is small (about ¼ inch long) and patterned with black and white body markings.

Black widows like dry, undisturbed places, such as lumber and rock piles, stacked pots or baskets, rodent burrows, water meters, the underside of bricks and stones, and dry crawl spaces. Females stay in the web.

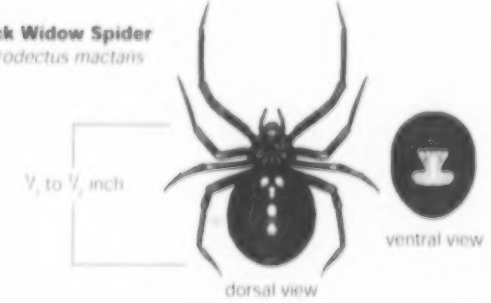
The female black widow spider spins an irregular, tangled web. The webs are typically constructed in quiet, undisturbed locations that are usually—but not always—close to the ground. The female spends her entire life in the web. If disturbed, she may drop to the ground to escape. Her eggs are placed in white, spherical sacs within the web. After hatching, the young spiders stay near the sac for a few hours to several days, and then climb to a high point, wait for suitable air currents, and spin a silken thread so they can float on the breeze like a kite. This method of "ballooning" distributes them over a considerable distance. Once they land, the spiders begin to construct their own webs. The abdomen of a young black widow is patterned with red, white, and yellow, but has the black legs and general appearance of the adult.

BITES

Black widows are shy, retiring creatures that bite reluctantly, and then only in self-defense when threatened. However, when a female is defending her egg sac, she can become quite aggressive.

A bite may not cause pain at first. However, after a few minutes, the bite site becomes quite painful. Symptoms from the bite of a black widow include headache, general body ache, nausea, chills, slight fever, shortness of breath, intense muscle pain, and rigidity of the abdomen and legs. Seek medical attention. If reactions are mild, treatment usually is not administered. However, medicine is available if symptoms do become severe. The bite of the black widow is usually more serious for a small child or an elderly person.

Black Widow Spider
Latrodectus mactans



First Aid for Spider Bites

Wash the area around the bite, calm the victim, and consult a doctor as soon as possible. Those particularly at risk are the very young, the elderly and sick, or people with high blood pressure. Although the illness and lesions from bites of some of the spiders discussed here can be serious, deaths are rare.

If possible, capture the spider so the specimen can be taken to a doctor. Proper treatment may depend on identifying the species. Even the squashed remains of the spider can be useful for identification purposes.

DETECTION AND MONITORING

Monitor for black widows at night with a flashlight or headlamp. This is the time when they move to the center of their webs and will be most visible. When making your inspections, focus on areas that are dark and undisturbed during the day, but not necessarily close to the ground.

Look in and around the following places:

- small crevices anywhere from the foundation to the eaves of buildings
- the undersides of outdoor wooden furniture (for example, beneath the seats in the corners where the legs are braced)
- piles of wood, bricks, stones, or similar materials
- the openings of rodent burrows
- water meters
- cellar doors
- outhouses
- storage rooms

Black widow webs have high tensile strength and, with a little experience, can be identified by the way they "pop" when broken. An experienced pest manager can use this information to find webs during the day.

Brown Recluse Spiders

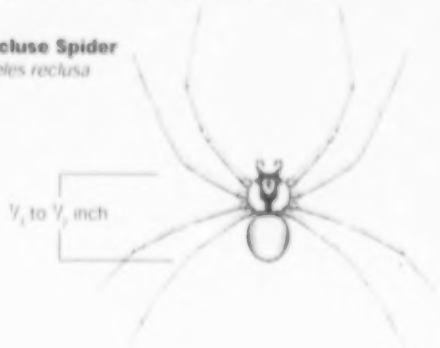
IDENTIFICATION AND BIOLOGY

Brown recluse spiders (*Loxosceles* spp.) are extremely uncommon in Pennsylvania and probably are found only in boxes brought in from the south. One species, *Loxosceles rufescens*, may be found in basements and utility tunnels. Brown recluse spiders, *L. reclusa*, are identified by their long, thin legs, an oval-shaped abdomen which is light tan to dark brown in color, and a very distinctive violin-shaped mark on their back. This marking, with the

violin "body" near the eyes and the "stem" of the violin extending backwards gives rise to their other common name, violin spiders. They have six eyes in three groups of two. Their overall size is ¼ inch to 1¼ inches long with the legs extended. The males are slightly smaller than the females.

As the common name "recluse" suggests, these spiders are shy, retreating from humans when possible. They prefer to build their webs in dark, undisturbed places on or near the ground. Unlike the black widow, brown recluse spiders hunt for prey some distance from their webs. They usually come into contact with humans because they have taken temporary refuge in clothing or bedding. Items left lying undisturbed on the floor, such as supplies, toys, or clothing, are perfect daytime refuges for these spiders. Such objects should be shaken out thoroughly if they have been on the floor for any length of time, particularly in regions where the brown recluse is prevalent.

Brown Recluse Spider
Loxosceles reclusa



BITES

Brown recluse spiders avoid areas of human activity. Bites are rare and are usually the result of unused rooms suddenly being put to use, or accidental contact resulting from pressing the spider between the body and either clothing or sheets. The bites are almost always very unpleasant, producing an ulcerous wound called a necrotic lesion that turns dark within a day and takes a long time to heal. Young children, the elderly, and the infirm are most likely to be affected severely. Victims should seek medical attention.

DETECTION AND MONITORING

The brown recluse spider wanders at night searching for prey. It seeks dark, uninhabited areas for protection. Brown recluse spiders usually are found on floors and baseboards. Only rarely are they seen on desks and tables.

Searches for this spider should concentrate on uninhabited areas close to the floor, particularly in boxes, around piles of paper, clothing, and debris, in closets, and under furniture. Periodic checks outdoors should focus on storage sheds, piles of debris or wood, cracks in the soil or in foundations, walls, and window wells, especially if small children play near these places. Employing sticky traps in monitoring is useful in establishing the extent of brown recluse infestations, and also is helpful in providing a measure of control.

AVOIDING SPIDER BITES

If either of these spiders is found around your school, it is important to be cautious when working near these places. Gardeners and custodians should be careful about where they put their hands when doing outdoor work, and wear gloves and a long-sleeved shirt when working around woodpiles and other items stored outdoors that are likely to harbor the spiders.

Make sure students and staff can identify any dangerous spiders in your area and know their likely nesting and hiding places. Children should be taught not to tease spiders in their webs or poke at them, and not to put their hands in dark crevices without looking first. The dangers of spider bites should be explained without exaggeration to avoid unnecessary fears. Teach students and staff that black spiders they see walking around are not likely to be black widows, since the females do not travel away from their webs and the males are not dangerous.

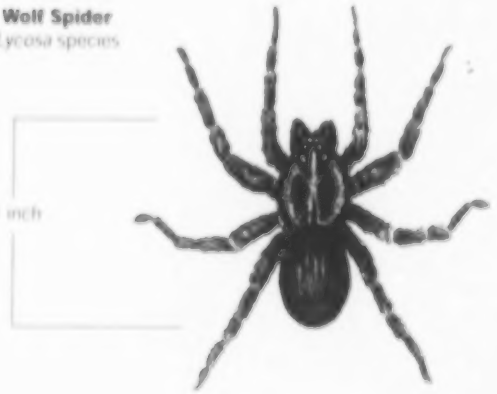
Other Spiders of Concern

Wolf spider (Lycosidae)

These large spiders are sometimes found indoors in basements in late summer and fall when cooler temperatures arrive. They do not construct webs, but run rapidly after prey. They are not aggressive, but may bite if handled. The bite is generally not dangerous.

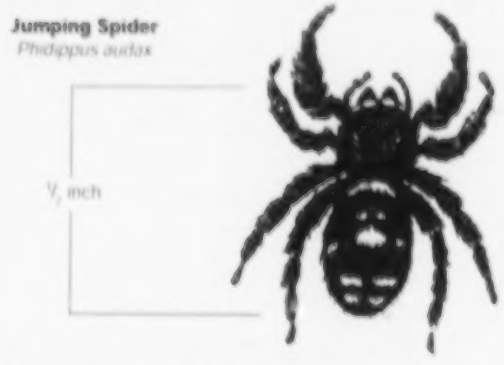
These and other spiders are best managed by cleaning and exclusion—keep screens in good repair, fix gaps around doors, and caulk cracks around window frames, as well as around pipes and wires coming into the building.

Wolf Spider
Lycosa species



Jumping spider *(Phidippus audax)*

These spiders move in jumps or short rapid runs. They are hairy, stocky, and about ½ inch long. This species is black with spots of orange or red on the top surface of the abdomen. At times, they are confused with black widow spiders, which are not at all hairy. Active during the day and usually outdoors, sometimes they are found inside on walls, windows, and screens. They can bite. Generally, they do not appear in large numbers and can be removed individually.

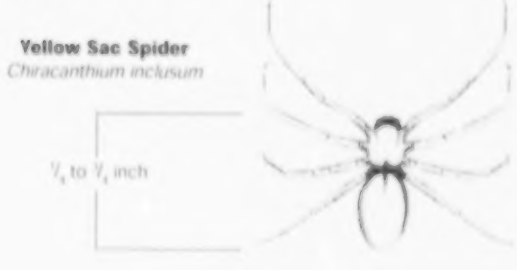


Yellow sac spider *(Chiracanthium* spp.*)*

These spiders have been associated with numerous cases of spider bites and cause a small irritating spot which may not heal for 8 to 10 days. They are suspected of being responsible for most indoor bites (Lyon, 1995).

This yellow spider, which is about ¼ to ⅜ inch long, may have a greenish tinge to the abdomen. The jaws are brown and the legs are very smooth, with the front legs longer than the rear. The egg sac is a white, paper-like disk usually placed in a protected area, such as under a stone.

They enter buildings principally in the early fall and are active for several months. They make small white webs in confined spaces where they spend the winter. In spring, they usually emerge from their white web cells and find their way outside. Outdoors, they do not build webs but instead construct a flat tubular sac opened at both ends inside rolled leaves or crevices, or under loose bark or stones.



MANAGEMENT OPTIONS

Physical Controls

To achieve some kind of permanent control of black widow spiders, you must attempt to eliminate not only the spiders but their preferred habitats as well. If this is not accomplished, another black widow may locate the same habitat and move in. If black widows regularly build their webs in certain locations indoors, try to modify these areas by increasing the light, caulking crevices, or reducing the insect population the spiders are feeding upon. As previously mentioned, check window and door screens for holes that give insects access, and make sure that foods and organic wastes are stored properly to prevent insect infestations. To reduce or eliminate possible web sites outdoors, debris and litter should be removed and discarded. All crevices in foundations and walls that are child-height and wide enough to stick a finger into should be caulked closed.

Because many spiders prefer undisturbed places for nesting and hiding, periodic, thorough cleaning can help reduce their numbers. Floors should be kept well vacuumed. Boxes of paper and other items stored in closets, or anywhere else that is dark and undisturbed, should be handled carefully when first inspected. A small hand-held, battery-powered vacuum also can be used while checking through stored items. If a spider is vacuumed up, the vacuum bag can be placed into a plastic bag and then into a freezer. Most bites from spiders probably occur when a spider is disturbed or handled. Wearing leather gloves while searching through stored items can help prevent bites.

IPM for Trees and Shrubs on School Grounds

INTRODUCTION

Landscapes vary so greatly that it would be impossible to provide specific management suggestions for all the pest problems on the many trees and shrubs that might be encountered on school grounds. Instead, we will try to provide a basic framework that will enable you to solve your own problems using information from your specific site. At the end of this manual are references to Penn State publications about lawns and landscaping in Pennsylvania. They may help with specific problems.

PLANT HEALTH CARE MANAGEMENT

Plant health care management (PHC) is a new concept in managing landscapes that was developed from the concept of integrated pest management (IPM). Many arborists, horticulturists, and landscape managers have long felt that IPM's focus on "pests" is too narrow when applied to landscape plants. More than half of the problems encountered in landscapes or gardens probably are not caused by insects, mites, or disease; instead, they are the result of compacted soil, drought stress, overwatering, frost damage, and many other factors. To manage landscapes effectively, plant health and the ecosystem in which the plant is growing must be taken into consideration. PHC takes just this kind of broad approach. PHC incorporates all the principles of IPM, including monitoring, record keeping, and integrating treatments, but PHC emphasizes plant health and proper horticultural practices. PHC is *plant* management, not just *pest* management. By focusing only on pests, we often overlook the horticultural or environmental factors that affect plant growth and health.

COMPONENTS OF A PHC PROGRAM

Van Bobbitt, community horticulture coordinator for Washington State University Cooperative Extension, lists the following 5 components of a PHC program (Bobbitt, 1994):

- Know your plants.
- Determine key problems.
- Study your landscape ecosystem.
- Promote plant health.
- Consider a variety of strategies to manage pests.

Know Your Plants

Before you can properly care for the trees and shrubs on your school grounds, you must know what they are. Make a map of the grounds and identify every tree and shrub. There are books that can help you with this, or you can take a specimen to a nursery, the Penn State Cooperative Extension office in your county, or a landscaping professional.

Once you know the names of all your plants, do some research on each one. Talk to nursery personnel and horticulturists, and read about your plants in gardening books. From your research, you should be able to answer the following questions:

- What kind of soil does the plant prefer?
- How much water does it need?
- When should it be fertilized?
- How should it be pruned?
- Does it prefer shade or sun?
- How much heat or cold can it tolerate?
- What are its most common pest problems?
- What environmental problems—soil compaction, air pollution, salt damage, and others—is it susceptible to?

Your research and your experience can help you identify key plants that are prone to problems and need more of your time and attention than other plants. If there are many trees and shrubs on the school grounds, this information can help you focus your maintenance activities. You also may want to use this information to remove plants that are not suited to their sites, that have too many problems, or that require too much care.

Determine Key Problems

Many things affect the health of a tree or shrub. They are generally divided into biotic factors and abiotic factors. Biotic factors are living organisms, such as diseases, insects, mites, and deer. Abiotic factors include maintenance practices (fertilizing, pruning, irrigation), weather, soil quality, amount of sunlight, and human activities such as vandalism or soil compaction caused by constant foot traffic. These abiotic factors probably are responsible for the majority of landscape plant problems.

Most of the information in this chapter is from *IPM for Schools: A How-to Manual*. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.

Determining key problems involves deciding which situations or factors are most likely to affect the health of your plants. Ask yourself if the problem is a serious threat to plant health, a minor threat, or just an aesthetic problem. Your research and your experience will help you answer these questions. For instance, one plant disease may kill a tree, but another disease may cause premature leaf drop year after year without seriously affecting tree health.

It is likely that you will have not only key problems, but also key problem sites. For example, perhaps the heavy equipment used in remodeling the school last year severely compacted the soil in several areas, or perhaps drainage is poor in one corner of the schoolyard because of heavy clay soil. These sites will need special attention, and most likely special plants, too.

Learn as much as you can about your key problems. If they are living organisms, learn about their life cycles, how to identify various stages of the pest, and how to recognize symptoms of damage. Do enough research to help you decide which management options are both safe and effective.

You also will need to research abiotic problems. Are there specific symptoms that you can learn to recognize? What techniques are available for solving the problem? Which solutions can you afford and which are best suited to the particular site? Are there specific plants that can tolerate the abiotic factors?

Study Your Landscape Ecosystem

The grounds of your school make up an ecosystem with complex relationships among the plants, animals, water, soil, sunlight, weather, and other components. Because of these complex relationships, there are many things you will need to pay attention to when promoting plant health. Questions you will need to answer include:

- What is your climate? What are the maximum and minimum temperatures?
- Are there microclimates in the school yard that might affect plant growth?
- Where do the prevailing winds come from? Are they unusually strong?
- What are your seasonal patterns of precipitation?
- Where are the sunny and shady parts of the yard? (These will change over time as plants grow and die.)
- What are the characteristics of the soil in each part of the yard?
- What are the drainage patterns?
- What is the history of each area in the school yard? What plants were grown there? (This can be an important factor for some plant diseases.) Was the area covered with asphalt or concrete at some point? Did a road or path go through the site?
- Are animals such as squirrels, deer, and dogs having an impact on the landscape? (The salts in dog urine can be very damaging to plants.)
- What human activities are having an impact on the landscape? Are children vandalizing plants? Are lawns growing right up to the trunks of trees so that mowers regularly damage the trees? Are city de-icing operations salting up the soil?
- What kind of irrigation system is installed in the landscape, and is it in working order? Are plants getting too little or too much water?
- Is air pollution a problem in your area? (Air pollution affects plants as well as animals.)

Since landscapes are constantly changing, you will need to monitor frequently in order to detect problems early. Monitor at least every two weeks during the growing season. In mild climates, you also should monitor once a month during the winter. Focus your monitoring efforts on your key plants and your key problems. Be aware that plants growing in poor conditions are under stress and are often more likely to suffer from insects and disease. As you monitor, look for the kinds of damage symptoms you learned about in your research.

Promote Plant Health

Proper plant care is the foundation of a PHC program. Healthy plants mean healthy landscapes, and healthy landscapes have fewer problems and require less special attention. The following points will help you to minimize cultural and environmental problems, as well as pest problems.

- Match the plant to the site. For example, you cannot grow a subtropical swamp plant in a cold, dry site. Some plants cannot grow in full sun, and some plants are better adapted to salty or compacted soil or soil with poor drainage. For help with finding plants for your area or for problem sites, talk to local gardening clubs, nurseries, or extension personnel, or consult books on regional gardening.
- Select pest- and disease-resistant species.
- Know what kind of care each plant needs, and pay special attention to how you water, prune, and fertilize them.

- Plant a diversity of species so that a single pest problem will not devastate your landscape.
- Include "insectary" plants in your landscapes. These are plants that attract and feed beneficial insects with their nectar and pollen; for example, sweet alyssum *(Lobularia* spp.), flowering buck-wheat *(Eriogonum* spp.), members of the parsley family (*Apiaceae*) such as fennel and yarrow, and members of the sunflower family (*Asteraceae*), such as sunflowers, asters, daisies, marigolds, and zinnias.
- Use proper planting techniques when installing vegetation.
- Improve the soil with organic matter and mulches.

Consider a Variety of Strategies

If you determine that a problem needs to be treated, it is important to consider a variety of strategies and to integrate those strategies into a comprehensive program. Treatment strategies can be divided into several general categories:

Education
This can include educating students and teachers about respect for landscape plantings; the more that students can be involved in the planting and care of various portions of the school yard, the less they will vandalize these areas. Education can also involve training maintenance staff in various aspects of plant care and plant selection.

Cultural controls
These usually include modifying horticultural practices to prevent plant problems or to improve plant health.

Biological controls
Biological control uses other organisms to combat pests. More and more beneficial organisms are becoming commercially available, and by planting "insectary" plants (see above), you can attract beneficial insects already in your area.

Chemical controls
Chemicals are not prohibited in a PHC program, but they are used as a last resort, and then they are used judiciously and in the least toxic formulations. Always spot-treat to minimize the amount of active ingredient used. **Pennsylvania law allows pesticide applications on school grounds only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator.**

No action
This can be a valid strategy in many situations when the problem does not seriously affect the health of the plant. Your research will help you understand which problems are serious and which are minor or simply aesthetic problems.

IPM for Weeds on School Grounds

INTRODUCTION

A "weed" is commonly defined as a plant growing in a place where it is not wanted. Plants can be unwanted because they compete with desired species, because they cause harm to people or structures, or because their appearance or odor is offensive. The designation "weed" can be quite subjective. For instance, the dandelion can be considered a weed in one setting and a wildflower or culinary herb in another.

On school grounds, there is usually consensus on the weedy nature of certain plant species, such as thistles, docks, crabgrass, and poison ivy, that spring up where they are not wanted. These species have common characteristics that enable them to "take over" when conditions are right. Landscapes can be designed and maintained in ways that minimize conditions suited to weed growth, reducing or eliminating the need for herbicides. The goal is to encourage desirable plants to outcompete weeds in habitats where plant growth is acceptable (shrub beds, turf areas, tree wells, student gardens), and to remove conditions conducive to weeds in areas where vegetation is not wanted (in pavement cracks, on running tracks, under fences). A review of basic principles of weed biology and ecology will help identify conditions that promote weed growth and suggest methods for encouraging competitive desirable vegetation and discouraging weeds. Extensive information concerning weeds in turf, identification and control can be found at: http://www.agronomy.psu.edu/Extension/Turf/WeedMgmt.html. (*The management of weeds in turf is discussed in the section on school lawns on page 63.*)

IDENTIFICATION AND BIOLOGY

Weeds can be found among both broadleaf plants and grasses. Like all plants, weeds are classified within 3 general categories according to the duration of their life cycle and their methods of reproduction.

Annuals

These are the most common weeds; they live 1 year and reproduce by seed. These plants have a rapid life cycle that enables them to germinate, shoot up, blossom, set seed, and die within the space of a few weeks or months. Their rapid life cycle allows them to thrive on a minimum of nutrients and water.

Biennials

These weeds live 2 years, and reproduce both vegetatively and by seed.

Perennials

These weeds live more than 2 years. Although perennials produce seeds, the main means of reproduction is usually vegetative; for example, by forming new plants from bulbs or corms, or by producing new top growth from buds located on underground stems (rhizomes).

Weed Habitats

Weeds tend to grow in places where the soil is bare or disturbed:

- areas that have been cultivated (shrub and flower beds)
- trampled or close-mowed lawns
- unpaved play areas and paths
- sports fields
- fence lines
- graded roadsides
- cracks in sidewalks or other pavement
- areas where the same herbicide has been used repeatedly and plants tolerant to that material have moved in

Weedy areas found on school grounds tend to be hot, dry, sunny habitats—often with low nutrient levels and soil moisture. Certain plants, such as thistles, knotweeds, plantains, and barnyard and crab grasses, take advantage of these conditions. As they grow, die, and decompose, the soil is stabilized, erosion is reduced, and the soil environment becomes more moist and fertile. Under these improved conditions, plant species with less weedy characteristics may eventually displace the weeds. Thus, a meadow left undisturbed may eventually become a forest.

DETECTION AND MONITORING

The purpose of monitoring is to determine if, when, where, and why weeds are growing or posing a problem, and to assign priorities for habitat change and least-toxic weed suppression. The components of effective weed monitoring are described here.

Most of the information in this chapter is from *IPM for Schools: A How-to Manual*. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.

Mapping Weed Habitats

The first step in monitoring is to map areas where weeds are growing. This does not need to be a detailed, time-consuming process—a rough map will do. For areas to monitor, see the list under Weed Habitats above.

Identifying Weed Species

It is important to accurately identify the most common weed species on your school grounds in order to determine appropriate management methods. Knowing the scientific name of the weed makes it much easier to obtain information from research professionals and the scientific literature. Assistance is available from county Penn State Cooperative Extension personnel or pictorial weed guides. A quick and effective method for preserving weed samples using plastic-covered index cards is described in the box below. This simple method results in a portable, easy-to-use weed reference.

Learn about the growing conditions required by the weed as well as its growth characteristics and methods of reproduction. Weeds can be indicators of soil conditions that need to be changed to discourage weed growth. For example, yellow nutsedge (*Cyperus esculentus*) often grows in waterlogged soils, indicating excessive water perhaps due to a broken irrigation pipe or valve. Conversely, prostrate knotweed (*Polygonum aviculare*) indicates dry, compacted soil that requires aeration and addition of organic matter. Changing the conditions indicated by the weed can discourage these unwanted plants from growing.

Record Keeping

It is important to record the time of year a particular weed species appears, its abundance, and its impact on the landscape. This information will help determine:

- which weeds and how many of each can be tolerated in a specific area without the weeds impairing the function of the landscape or its aesthetic appeal
- whether or not management strategies are effective
- whether weed populations are rising, falling, or staying about the same from year to year
- whether new species of weeds are becoming a problem (as often happens as a result of weed management efforts)

Without this information, it is impossible to determine the long-term effectiveness of management methods.

Collecting and Preserving Plant Specimens for Identification

If you want to have a damaged plant inspected or a weed identified, place the plant and a moist paper towel inside a plastic bag. If you are unable to deliver the specimen in person, place the bag inside a padded mailing envelope. If you cannot mail the specimen immediately, however, it is likely to shrivel or mold. In that case, use the procedure outlined below.

Find a stiff index card or piece of white poster board large enough for the specimen, then cut a piece of clear contact paper that overlaps the card ¼ inch on all sides. A sheet of aluminum foil spread over the work surface will prevent the contact paper from sticking in the wrong place. Separate the backing from the contact paper and lay the paper over the plant, pressing out bubbles by moving your hand from the bottom to the top.

Cut off the corners of the contact paper, then fold the paper over the back of the card. Write the name of the weed (if known), the date, and the location where it was collected on the back.

Plants preserved in this manner can also be kept in a file for future reference regarding weeds and pest damage symptoms.

Establishing Weed Tolerance Levels

School landscape maintenance budgets rarely stretch far enough to suppress all weeds, even if that were desirable. Aesthetic standards should be adjusted to take this into account. Assigning tolerance levels helps prioritize budget allocations, facilitate long-term plans, and provide justification for weed management action—or lack of action.

Identify areas where weeds pose potential health or safety hazards or threaten damage to facilities, and distinguish these locations from those where weeds are considered aesthetic problems alone. For example, poison ivy can cause severe skin rashes and itching, and weeds growing in playing fields or running tracks can pose tripping hazards. Assign low tolerance levels to weeds in such areas, and place high priority on their management. On the other hand, assign higher tolerance levels—and lower priority for management—to weeds growing in shrub beds or along fence lines.

Since most weed tolerance levels are subjective, one way to establish them is to invite a representative group to tour the school grounds and decide where weed levels are

acceptable and where they are not. Such a group might include the school principal, coach, landscape maintenance supervisor, PTA officers, students, and parents. It is important that this group reach consensus on overall weed management objectives for various school sites, and that weed tolerance and action levels derive from this agreement. Weed tolerance levels can be reevaluated on an annual basis.

Long-Term Weed Management Plans

Long-term plans should focus on making changes to the habitat to permanently exclude weeds in areas where weed tolerance levels are low. In some cases this may require augmented budget allocations. Developing plans can help spread budget needs over several years.

Evaluation of Weed Management Programs

The availability of herbicides has often helped perpetuate poor landscape designs and inappropriate maintenance practices, because herbicides could be used to compensate for them. Gathering monitoring data can pinpoint the underlying causes of weed presence. The data can be used to change design specifications for landscapes, sport fields, playgrounds, and pavement to avoid encouraging weeds.

The long-term costs, risks, and benefits of various weed management approaches also should be evaluated. A one-time cost to install concrete or asphalt mow strips under backstops and fence lines and thereby permanently remove weed habitat may be less costly in the long run than repeated herbicide use that may pose a potential health risk, possibly resulting in lawsuits and poor public relations.

MANAGEMENT OPTIONS

Horticultural Controls

This approach involves manipulating plant selection, planting techniques, and cultural practices so that desired vegetation grows so densely and vigorously that weeds are crowded out.

Planting beds can be rototilled and irrigated to force weed seeds to germinate. As soon as sprouted weeds appear as "green fuzz" on top of the soil, they can be killed by a second cultivation with the tiller set at 1 inch. Shallow cultivation prevents weed seeds from being moved to the top 2 inches of soil—the germination range. This will reduce weed growth while ornamental plants are becoming established.

Plant Selection

In shrub beds, you can include ground covers with rapid, spreading growth habits that can outcompete weeds.

Competitive Interplanting

When shrubs or ground covers are installed, weeds often colonize the spaces between individual plants before the ornamentals can spread and shade them out. These weed habitats can be eliminated by overseeding newly planted areas with fast-growing annual flowers such as sweet alyssum (*Lobularia maritime*), farewell-to-spring (*Clarkia amoena*), and scarlet flax (*Linum grandiflorum* var. *rubrum*).

Mulching

Mulches are used primarily to exclude light from the soil, thus limiting weed seed germination. Mulches can be composed of organic materials (compost, wood chips), stones or gravel, or synthetic landscape fabric. Landscape fabric is preferred over black plastic, since it allows air and water to move through the soil to benefit ornamental plant roots, but excludes light at the soil surface to thwart weeds.

To be effective, mulches should be applied immediately after plants are installed. Bark or compost mulches should be 3 to 4 inches deep to exclude light. If landscape fabric is used, it should be covered with an inch or two of bark, stones, etc. to improve the aesthetic appearance of the planting area and reduce degradation of the fabric by sunlight. Landscape fabric can last for years if properly maintained.

Physical Controls

Hand-pulling, cultivation, and using string trimmers and mowers are very effective weed suppression techniques. If labor is in short supply, make good use of parent and student volunteers, community service groups, and youth groups. Classrooms can adopt a flower bed or a section of the schoolyard to maintain and beautify. If students are involved in grounds maintenance, they will be more careful around the plants and take pride in a clean, well-maintained schoolyard.

Weeds on baseball infields, running tracks, and other bare soil areas can be suppressed by periodic shallow cultivation with a tractor-mounted rotary harrow, also called a rotary hoe or power rake (Rhay, 1994). In areas with heavy clay soils, this method can be combined with adding sawdust to reduce the crusting and puddling characteristics of these soils.

Eliminate Weed Habitat

Creating a "mow strip" under and immediately adjacent to fence lines can solve a common weed problem. When fences surround paved playing surfaces such as basketball courts, the steel fence posts can be installed directly into the paving material, 8 to 12 inches to the inside of the paving edge. The paving prevents weeds from growing under or adjacent to the fence, and provides a paved strip for the wheel of a mower which can keep adjacent grass trimmed. The strip also provides access for use of string trimmers when shrub beds abut the fence line.

Pouring a 16-inch-wide concrete or asphalt strip to cover the soil under and beside the fence can modify existing cyclone fence lines. This retrofit can be performed in stages over several years as budgets permit. The one-time paving cost will produce many years of savings in weed management.

Use asphalt or cement crack filler to fill cracks in paved areas where weeds are a problem.

Flaming

Flamers are used by a growing number of parks and school districts to treat weeds in pavement cracks, under picnic tables and benches, along fence lines, and similar places. This technique uses a small gas- or propane-fired torch to sear the tops of young weeds. The heat raises the temperature of the sap in the plant cells, the cell walls rupture, and the weed wilts and dies. Flaming is most effective on young annual and perennial weeds in the seedling (4- to 5-leaf) stage, because at that point the fragile root system is killed along with the top growth. Grasses are difficult to kill by flaming because a protective sheath covers their growing tips.

Keep the torch about 6 inches above the vegetation and pass it slowly over the plants. Hold the flamer over each plant briefly so the plant is heated but not actually burned. The leaves may lose their usual green color, but there may not be any evidence of wilting, let alone plant death, for several to many hours. Leaves that have been heated sufficiently to burst cell walls will feel very soft to the touch and may turn a purplish color.

Soil Solarization

This technique uses a covering of clear plastic to raise soil temperatures high enough to destroy weeds and their seeds. For solarization to be effective, daytime temperatures should average 85°F or more, so it should be done during the hottest and sunniest time of the year. Solarization can kill annual or perennial weeds as well as soil pathogens and nematodes. Solarization can also be used to destroy weed seeds and other soil pests in rototilled beds scheduled for new plantings.

To solarize a section of soil, do the following:

- Mow any existing vegetation to the ground.
- Cultivate to incorporate the vegetation into the soil.
- Provide a smooth surface by raking the soil so it is level.
- Encourage weed seeds to germinate by irrigating the soil 1 to 2 weeks before covering it.
- Irrigate again just before laying down the plastic.
- Use UV-stabilized plastic 2 to 4 mils thick.
- Anchor the tarp by burying its edges in a small soil trench around the area to be solarized.

Chemical Controls

When nonchemical weed management methods are not sufficient to solve weed problems, herbicides are available for integration into the program. There are many herbicides on the market. For information on the efficacy and hazards of various herbicides and on how to select an appropriate product for your situation, consult the Penn State Cooperative Extension office in your county.

Whenever possible, apply herbicides as spot-treatments to the target weeds. For example, a tool called a "rope wick applicator" can be used to wipe a small amount of herbicide on a single plant or patch of weeds. This reduces human exposure and helps to protect nontarget vegetation and beneficial soil organisms that can be damaged or killed by herbicide residues. Wick applicators are available as hand-held versions or as attachments to small tractors and riding mowers.

When applying herbicides, use a colorant to mark the treated area. This will not only ensure even coverage, but also will help passersby see and avoid the treated area. Do not allow children to play or lie on the treated area—rope it off and post a sign.

Herbicides must be used in accordance with their EPA-approved label directions. **Pennsylvania law allows pesticide applications on school grounds only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator.** All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Never apply these materials where they might wash into the storm drains, sanitary sewer, creeks, ponds, or other water sources.

IPM for Wood-Damaging Pests in Schools

INTRODUCTION

The job of maintaining a building includes detecting structural pest problems before they become severe. Early detection means less costly repairs. Although the discovery of wood-destroying insects often generates panic and premature decisions, these pests are slow to cause new damage. There is ample time to accurately identify the pest and decide on an appropriate IPM program. Some of the work can be done by school personnel and the rest contracted out to a professional, or the entire job can be contracted out to professionals.

This section will discuss wood-attacking fungi, termites, and wood-boring beetles.

IDENTIFICATION AND BIOLOGY

Wood-Attacking Fungi

Fungi reproduce from spores present in the air and soil. Thread-like structures called hyphae grow from the spores and penetrate directly into wood. A mass of hyphae, called a mycelium, is frequently visible on the surface of the wood. A mycelium often takes the shape of a fan or a fluffy mat. Optimal growth occurs at temperatures between 50°F and 95°F on wood containing at least 20 percent moisture.

The three major groups of wood-attacking fungi are **surface-staining fungi** (molds and mildews), **sap-staining fungi** (wood stains), and **decay fungi** (wood rots). Surface-staining and sap-staining fungi do not cause loss of structural strength and will not be discussed here; however, they are evidence of moisture problems that need to be corrected. The third group, decay fungi, attacks the cellulose and lignin in wood and causes structural weakness. They are hard to detect in their early stages; however, advanced stages are quite evident from the changes in the wood's appearance.

Brown Rot

- characterized by white mycelial mats
- causes wood to crack into small cubical pieces perpendicular to the wood grain
- wood rapidly loses its strength and eventually crumbles to powder
- wood changes color to a distinctive brown

Dry Rot or Water-Conducting Rot

- a special kind of brown rot most often found in new construction
- can disperse rapidly throughout wood, destroying large amounts in 1 to 2 years
- characterized by large, papery, white-yellow mycelial fans
- forms large tubes called rhizomorphs that are up to an inch in diameter and can conduct water to 25 feet
- rhizomorphs are dirty white to black, and grow out and away from the moisture source
- rhizomorphs allow the fungus to extend its growth into dry wood containing less than 20 percent moisture
- wood surface may appear sound but wavy, even though the interior is heavily decayed
- relatively rare problem

White Rot

- makes wood look bleached
- affected wood feels spongy when probed and is stringy when broken
- no abnormal shrinkage
- wood strength gradually diminishes

Soft Rot

- seldom encountered in buildings, except where wood is in contact with constantly wet soil
- develops in marine habitats in wood that is too wet for other decay fungi
- attacks wood surfaces and produces a gradual softening inward

IDENTIFICATION AND BIOLOGY

Termites

Although there are a number of groups of termites in the United States, only the eastern subterranean (*Reticulitermes flavipes*) and southeastern subterranean (*Reticulitermes virginicus*) termites are indigenous to Pennsylvania, with the eastern subterranean being the most common. They are social insects and form colonies that contain several castes. These castes differ greatly in their form and function.

Most of the information in this chapter is from:
IPM for Schools: A How-to Manual. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.
Jacobs, S. B. *Eastern Subterranean Termites*. Penn State Cooperative Extension. 1992.

During the first 6 months of the development of a new colony, the queen deposits only 6 to 20 eggs. The total number of eggs deposited by a queen can be tens of thousands during her lifetime. Nymphs hatch in 6 to 12 weeks. As the nymphs increase in size and number, castes are formed. The worker caste maintains and feeds the colony, and many species have a soldier caste that defends the colony. The darkly pigmented, winged reproductive caste (kings and queens) serves only to reproduce and start new colonies. Reproductives "swarm," or fly away from their original colony, only at certain times of the year.

Subterranean Termites *(Reticulitermes flavipes)*

- Subterranean termites must be in regular contact with moisture, which in most cases means they must stay in contact with the soil. (In rare cases, they live in the wood above the soil, getting their moisture from a leaky air-conditioner, regular condensation, or some other constant moisture source).
- They construct distinctive earthen tubes to bridge the distance between the soil and wood.
- The passageways protect them from predators and help prevent desiccation as they travel. These tubes are important visible clues to subterranean termite presence.
- Initially, subterranean termites tunnel into soft spring wood, but as the infestation grows, they remove more and more wood until most of it is gone.
- They reinforce their excavations with "carton," a mixture of wood fragments and fecal material held together by saliva.

R. flavipes usually swarm in Pennsylvania between February and June. These black, winged termites are the stage most commonly seen, since the other castes do not expose themselves to light. Winged termites are attracted to light, and when they emerge within buildings, they swarm about doors and windows. After crawling or fluttering about for a short time, the termites break off their wings and locate a mate. Each pair attempts to locate moist wood in contact with the soil to start a new colony, but few succeed. Most reproduction is due to secondary or supplementary reproductives within the colony. No damage is done by the winged forms.

IDENTIFICATION AND BIOLOGY

Wood-Boring Beetles

Although some wood-boring beetles can cause serious damage, there is always time to identify the type of beetle present before taking action. When dealing with wood-boring beetles, it is important to know whether or not they will reinfest a piece of wood. Some beetles cannot, and seeing their holes in wood means they have done their damage and left. See Table 7 on page 86 for more information to help you identify some of the most important beetles.

Anobiid Beetles (sometimes called death-watch or furniture beetles)

These beetles are small ($\frac{1}{8}$ to $\frac{1}{4}$ inch long), reddish-brown to black, and elongate with a very rounded back. Wood moisture content of 13 to 30 percent is required for development, so anobiids are more frequently a problem in areas with higher temperatures and humidity. Furniture kept in centrally heated living spaces is usually too dry for them to infest.

Anobiids attack both hardwoods and softwoods and will feed on either newly seasoned or older wood. In Pennsylvania, they are the most common structure-infesting beetle. Although they feed mainly on the sapwood, they also can damage heartwood that is close to the sapwood. In the wild, they live in dead tree limbs or in bark-free scars on the trunks.

The females lay their eggs in small cracks or crevices on the surface of the wood. When the larvae hatch, they bore a short distance into the wood, then turn at a right angle and tunnel with the grain. Their tunnels get larger as the larvae grow. Eventually the tunnels become so numerous that they intersect, and the wood becomes a mass of fragments. Tunnels are packed with fecal pellets from the larvae. It may take 2 to 3 years for larvae to complete their development.

Lyctid Powderpost Beetles

These are small ($\frac{1}{8}$ to $\frac{1}{4}$ inch long), slender beetles that vary from reddish-brown to black. Lyctids attack only the sapwood (outer wood) of hardwoods.

Females lay an average of 20 to 50 eggs in exposed areas of partially seasoned lumber with a high starch content. The hatched larvae bore down the vessels of the wood, making straight tunnels that then turn and become irregular. Most species complete their life cycle in 9 to 12 months, but they can develop more quickly if the temperature and starch content of the wood are favorable. The larvae pupate near the surface of the wood, and the emerging adults drill a hole through the wood to get out.

TABLE 7.

Characteristics of Damage Caused by Common Wood-Boring Beetles

	Wood Attacked		Recognizing Damage			
Type of Borer	**Part and Type**	**Condition**	**Exit Holes**	**Galleries (tunnels)**	**Frass**	**Reinfest?**
Anobiid powderpost beetles Anobiidae	Sapwood of hardwoods and softwoods; rarely in heartwood	Newly seasoned or older wood	Circular, 1/16 to 1/4 inch diameter	Circular, up to 1/4 inch diameter; numerous; random	Fine powder with elongate pellets conspicuous; loosely packed in isolated clumps of different sizes; tends to stick together	Yes
Bostrichid powderpost beetles Bostrichidae	Sapwood of hardwoods primarily; minor in softwoods	Seasoning and newly seasoned	Circular, 1/32 to 1/16 inch diameter	Circular, 1/16 to 1/8 inch diameter; numerous; random	Fine to coarse powder; tightly packed; tends to stick together	Rarely
Lyctid powderpost beetles Lyctidae	Sapwood of ring- and diffuse-porous hardwoods only	Newly seasoned with high starch content	Circular, 1/32 to 1/16 inch diameter	Circular, 1/16 inch diameter; numerous; random	Fine, flour-like; loose in tunnels	Yes
Round-headed borers (general) Cerambycidae	Sapwood of softwoods and hardwoods; some in heartwood	Unseasoned; logs and lumber	Oval to circular, 1/4 inch to 1/2 inch diameter	Oval, up to 1/2 inch diameter; size varies with species	Coarse to fibrous; may be mostly absent	No
Old house borer *Hylotrupes bajulus*	Sapwood of softwoods; primarily pine	Seasoning to seasoned	Oval, 1/4 to 1/2 inch diameter	Oval, up to 1/2 inch diameter; numerous in outer sapwood; makes ripple marks on walls	Very fine powder and tiny pellets; tightly packed in tunnels	Yes
Flat oak borer *Smodicum cucujiforme*	Sapwood and heartwood of hardwoods; primarily oak	Seasoning and newly seasoned	Slightly oval; 1/16 to 1/8 inch diameter	Oval, up to 1/2 inch diameter	Fine granules	No
Flat-headed borers Buprestidae	Sapwood and heartwood of softwoods and hardwoods	Seasoning	Oval, 1/16 to 1/2 inch diameter	Flat oval, up to 1/2 inch long diameter; winding	Sawdust-like; may contain light and dark portions if under bark; tightly packed	No
Bark beetles Scolytidae	Inner bark and surface of sapwood only	Unseasoned; under bark only	Circular, 1/32 to 1/16 inch diameter	Circular, up to 1/16 inch diameter; random	Coarse to fine powder; bark-colored; tightly packed in some tunnels	No
Ambrosia beetles Scolytidae	Sapwood and heartwood of hardwoods and softwoods	Unseasoned; logs and lumber	Circular, 1/16 to 1/4 inch diameter	Circular; same diameter as holes; across grain; walls stained	None present	No
Wood-boring weevils Curculionidae	Sapwood and heartwood of hardwoods and softwoods	Slightly damp, decayed	Raggedly round or elongate, 1/16 to 1/4 inch diameter	Circular, up to 1/16 inch diameter	Very fine powder and very tiny pellets; tightly packed	Yes

Adapted from Moore, 1995

BEST COPY AVAILABLE

You are unlikely to see adult beetles during an inspection, and the larvae are always inside the wood. There is no outside evidence of infestation on wood that has been attacked for only a short time; however, once adult beetles emerge, you will see their small exit holes in the wood. You may also see piles of fine, flour-like frass (beetle excrement) that sifts from the holes.

Larvae usually pupate in the spring. The newly emerged adults bore holes straight out of the wood, and a large proportion of the females lay eggs in the same wood from which they emerged.

Old House Borer *(Hylotrupes bajulus)*

These beetles are brownish black, slightly flattened, and about ¾ to 1 inch long. The segment just behind the head is marked by a shiny ridge and two shiny knobs that suggest a face with two eyes. These beetles have become very common in Pennsylvania.

Despite being called the "old" house borer, this insect is also very common in new construction. This beetle attacks coniferous wood, such as pine, spruce, hemlock, and fir. The female lays her eggs in cracks and crevices on the surface of wood, and the hatched larvae sometimes crawl around before finding a place through which they can bore into the wood. They remain near the surface, feeding on the sapwood and only gradually penetrating deeper as they grow. They do not feed on heartwood.

The larval period may be completed in 2 to 3 years, but it can take as long as 12 or 15 years in dry wood, such as that found in attics. Old house borer tunnels have a distinctive rippled appearance on the inside. Unless the moisture content is high, the tunneling proceeds slowly. The larvae, while chewing with its hard jaws, emit a rasping or clicking sound (very similar to the sound produced by clicking fingernails).

Although this beetle can reinfest wood, the likelihood of this happening in buildings that are occupied, heated, and well ventilated is small.

DETECTION AND MONITORING

It is important to determine exactly which organisms are present and causing damage before deciding on treatment strategies. The actual damage caused by structural pests occurs slowly over a period of months or years, so there is time to study the situation and make a decision. Correct identification of the pest is critical to determining appropriate management strategies. The diagnostic key on the next page will help you identify the pest that is causing the problem. Note that in some cases more than one kind of wood-damaging pest may be present. The diagnostic key describes the major groups of wood-boring beetles and the damage they cause. Wood-boring beetles can be distinguished from one another by the type of frass they produce and the size and shape of the holes they create. It is important to distinguish between those species of beetles that can reinfest wood, causing extensive damage, and those beetles whose damage is limited to one generation.

If you are uncertain about which pest is present, get a professional identification from the Penn State Cooperative Extension office in your county or a pest management professional. The time and potential expense needed to correctly identify the pest will be compensated by the fact that you will be able to develop an effective management program for your school.

Regular Monitoring

Monitoring means looking for signs of damage to the wooden parts of the structure on a regular basis. Information gathered from these regular site inspections should be written down. Include a map of the site with notes about problem areas. Monitoring should show whether a pest problem is getting worse and requires treatment, and whether the treatment has been effective.

TABLE 8.

Diagnostic Key to Wood-Attacking Organisms Based on Symptoms

Fungi: Wood damaged and discolored with shrinkage and or loss of structural strength. Colored stains or dusty coating on underside of floor, on walls, or on ceilings.	
Specific Symptoms	**Probable Cause**
Blue stain visible in sapwood.	**Blue stain fungus**
Fan-shaped white fungal mat with large, 1-inch-wide, dirty white, brown, or black thread-like strands (mycelia).	**Poria fungus**, or "**dry rot**"
Soft decayed wood with mycelia and checking (cracking) at right angles to the grain of the wood, particularly on floor or perimeter joists. Wood looks brown and crumbles to a powder when touched.	**Brown rot**
White mycelial mass covered with irregular specks or pocks.	**Fomes fungi**

Insects: Holes, tunnels, galleries, or chambers on or beneath the surface of the wood.	
Specific Symptoms	**Probable Cause**
Holes greater than ½ inch in diameter.	**Carpenter bees**
Holes less than ½ inch in diameter.	**Wood-boring beetles**
Galleries or chambers found in wood. The wood surface is easily penetrated with a screwdriver or ice pick.	**Termites**
Earthen tubes or tunnels running from soil to wood.	**Termites**
Swarming winged insects at base of fence post, foundation, or indoors, or a collection of wings but no insect specimens.	**Ants** or **Termites**
Large bumble bee-like insects flying around exterior near the eaves of the house. Some enter large holes. Damage mostly confined to siding or outer boards.	**Carpenter bees**
Sawdust or tiny wood scraps on floor.	**Carpenter ants**

Monitoring for structural pests should be regarded as an ongoing responsibility, repeated every 1 to 5 years depending on the kind of problems in your area. Early detection of structural pest activity will result in considerably less expensive treatment later.

School Staff Responsibilities for Monitoring

All personnel responsible for maintaining wooden structures should be trained to identify the conditions that can lead to infestation by wood-damaging pests. (See the inspection checklist at the end of this chapter.) On page 89 is a list of equipment needed for monitoring.

If monitoring by school personnel indicates signs of termite or wood-boring beetle activity, a more thorough inspection should be made by a pest management professional. These staff members should also be trained to recognize obvious signs of damage, such as those listed under symptoms in Table 8. Although major structural pest management decisions should be based on the recommendations of a trained inspector, having someone on the school district staff who is knowledgeable about structural pests and can supervise outside contractors may improve the quality of pest management and contain costs.

Tools and Safety Equipment for Monitoring Termites and Other Wood-Boring Insects

- Flashlight with spare batteries and bulbs
- Screwdriver or ice pick for probing wood suspected of being infested
- Hammer or similar instrument for hitting wood and listening for indications of hollowness
- Ladder for inspecting roof trim and other off-ground areas
- Moisture meter with a range of at least 15 to 24 percent moisture
- Pencil, clipboard, graph paper, and measuring tape; with these, records can be made precisely on the floor plan or elevation of the building where moisture is evident or wood is damaged
- Tools for opening access entrances into crawl spaces
- Hacksaw blade for checking earth-filled porches adjacent to crawl spaces; when inserted under the sill, the thin portion of the blade should not penetrate beyond the sill or headers
- Good-quality caulk, such as silicone seal, and a caulking gun to plug suspicious exterior cracks and crevices; silicone seal is also available in a thinner consistency that can be applied with a brush

Using a Pest Management Service

When contracting for structural pest management services, the choice of a company should be based partially on their willingness to provide monitoring services for a fee separate and distinct from treatments. Some pest management professionals offer free termite inspections with the expectation that the inspection cost will be covered by the fees for the treatments that follow.

You can use the checklist at the end of this chapter to confirm the thoroughness of an inspection performed by a professional. Inspect both the inside and the outside of the buildings.

If a professional is hired to do the inspection, ask to see locations that were infested and/or were found to have damaged wood. Discovering subterranean termite tubes or beetle damage is not necessarily evidence of an active infestation. Termite tubes or beetle exit holes or frass indicate only that termites or beetles were there at one time. In the case of beetles, the adults that made the exit holes may have been the last beetles that will ever emerge if they are from a species that does not reinfest wood. Treatment of inactive infestations would be an unnecessary expense. Ask for confirmation that living termites or beetles are present, as some companies do not make this confirmation normal practice.

Detection Techniques for Termites

There are several ways to identify termite activity. The observation of swarming reproductives is an indication of a current termite infestation in the area, but simply finding a pile of discarded wings can be misleading. Winged termites are attracted to light and so could come from other areas. If only swarming insects are seen, a distinction must be made between ants and termites. The easiest way to distinguish between the two is to look at their waists. A termite has a broad waist, while an ant has a narrow, wasp-like waist. The four wings of the termite are all of equal length and nearly twice as long as its body, while the front and hind wings of an ant are unequal in length and not twice as long as its body length.

The discovery of a mud tube extending from the soil up to the wood is an indication of probable subterranean termite infestation (these tubes are described on page 85). If only one tube is located, monitoring for other tubes should begin immediately. Break open tubes to see if the termites are active or if the tubes are deserted; an active tube will be rebuilt within a few days. Finding soil in cracks and crevices can also be an indication of subterranean termites.

It isn't always possible to detect damaged wood by looking at the surface. An ice pick can help you probe the wood, and listening for sound differences while pounding on the wood surface can help you find the hollow areas.

For many years the only structural pest detection method available was visual observation by trained, experienced pest management professionals. This method has been improved by such inspection tools as the moisture meter.

The Pick Test

When monitoring your building, use an ice pick or screwdriver to probe wood you think might be decayed based on its color or other changes you detect. Insert the pick about ¼ inch into the wood and press sharply downward perpendicular to the grain. If the wood is sound, a long splinter will pull out of the wood along the grain (as shown in the figure to the right). If the wood is decayed, the splinter will be brittle and break into short pieces across the grain, especially at the point where the pick enters the wood and acts as a lever. You can also detect decayed wood by its lack of resistance relative to sound wood. Mud-sills (wood installed on footings) can be pick-tested without producing excessive visual or structural damage, since they are not visible from outside the crawl space. Sometimes wood treated with a preservative on the surface is decayed inside. The pick test can help reveal these hidden pockets of decay.

Moisture Meters

A moisture meter with a 15 to 24 percent range (to detect favorable conditions for anobiids) will help determine whether or not the moisture content of the wood is high enough to support the growth of wood-inhabiting fungi, wood-boring beetles, or subterranean termites. The needles of the meter should be inserted along the grain of wood to give the most accurate readings. Temperature corrections should be applied to readings taken below 70° and above 90°F (correction tables are supplied with meters). The meters should not be used in wood treated with water-borne wood preservatives or fire retardants.

Monitoring for Beetle Infestations

When wood-boring beetle larvae mature into adults inside the wood, they bore exit holes to the surface to get out. Table 8 on page 88 can help you determine what kind of insect created the holes you find. If it is a beetle, the information in Table 7 on page 86 will help to identify the kind of beetle and whether or not it is capable of reinfesting. Consulting with a professional is also advised.

Discovering beetle damage is not necessarily evidence of an active infestation. Signs that the infestation is still active include fresh frass the color of new-sawn wood and live larvae or adults in the wood. Where you suspect an infestation of the kind of beetles that do not emerge for several years (such as old house borers), you can confirm their presence by listening for the chewing sounds they make inside the wood. To amplify the sounds, use a doctor's stethoscope or a cardboard tube from a roll of paper towels. You can also place a cloth or piece of paper underneath the suspicious area for a week or two to monitor for the fresh debris and frass that are indications of activity for some beetles.

MANAGEMENT OPTIONS

Habitat Modification *(All Wood-Damaging Pests)*

No structural pest management program is complete unless the conditions that favor the survival of the pest are modified. Moisture in or on wood is the single most important predisposing condition for wood damage and structural failure.

Reduce the Moisture Level of the Wood

The investment in installing, fixing, or relocating gutters, siding, roofing, vents, drains, downspouts, and vapor barriers will pay for itself in long-term protection against termites, wood-boring beetles, and fungi. Leaking pipes, drains, sinks, showers, or toilets should be repaired. For wood-boring beetles and fungi, often the only management measures necessary are fixing leaks, installing vapor barriers, and using central heating to dry out wood and keep it dry. The most common wood-boring beetles cannot establish themselves in wood with a moisture content below 8 percent, and the old house borer probably needs more than 10 percent moisture. Wood must contain at least 20 percent moisture before it will support the growth of fungi. Few species of fungi can extend their growth into dry wood, and these fungi are relatively rare.

In cases where wood is excessively damp or difficult to dry out, an immediate treatment by a professional may be necessary.

Ensure Proper Drainage Under Buildings

If the soil under buildings is constantly wet or becomes wet after it rains, this problem should be corrected. Equip downspouts with plastic extensions to direct water away from foundations. Grade the soil around the building to slope gently away from the structure. Installation of a vapor barrier under the building will correct many situations, but more serious moisture accumulations need

other measures. Coat foundation walls with rubberized asphalt membranes to reduce moisture under the building. Extreme cases may require the installation of a sump pump and/or Power Temp-Vent. French drains can also be installed. French drains are lengths of perforated pipe covered with crushed stone placed around and below the foundation footings to catch and conduct water by gravity to a free flowing outlet or sump pump. The drains are normally covered with a building paper or straw before being backfilled with soil to the normal surface grade.

Improve Irrigation or Landscape Practices to Decrease Water Collection Near Buildings
Remember that water that falls on the sides of buildings from sprinklers can cause as many problems as natural rainfall.

Eliminate Direct Contact Between Wood and Soil
Ideally, wood should be at least 8 inches above the soil to prevent direct access by subterranean termites, prevent wood from absorbing excessive moisture, and facilitate the inspection process. Wood in contact with the soil must be replaced with concrete. If wood is too close to the soil, remove some of the soil and grade it so that it slopes away from the building.

Replace Damaged Wood with Treated Wood
After managing the pest problem, if wood must be replaced, especially wood in vulnerable areas, it can be treated with borates (see discussion under Chemical Controls) to protect it from fungal decay and make it less attractive to termites. Whenever wood will be exposed to the weather, it is important to paint a water repellent on the bare wood before it is stained or painted. Depending on the product, water-sealed wood must dry for a few days to over a month before being painted. Studies show that wood treated in this manner resists weathering and decay many years longer than wood that is only painted or stained.

Replace Moisture-Prone Wood with Aluminum, Concrete, or Vinyl
Sometimes it is more cost-effective to eliminate wood altogether from the most vulnerable areas of the building.

Remove Tree Stumps and Wood Debris
Decaying stumps, construction debris, and wood scraps near or under the building can be a source of termite infestation. Remove all wood debris and stumps within 10 feet of foundations. Never bury wood pieces; they can become termite nesting areas. Small pieces of wood debris containing live termites can be soaked in soapy water to kill the insects. Wood debris containing live termites should be taken to a landfill or other area where the natural decomposing abilities of termites are useful.

Store Woodpiles Properly
Firewood or lumber piles should be constructed so that no wood rests directly on the ground. Use cinder blocks or concrete as a base on which to pile lumber or firewood and inspect the pile periodically. Large piles should be as far from the building as is practical; smaller amounts of wood can be moved closer to the building as they are needed, but do not store logs inside or in a place where they can touch the building or a wooden deck.

Plant Trees Away From Buildings
Because trees and shrubs used in landscaping are often planted when young, a common mistake is to site them too close to a structure. Roots, branches and eventually decaying stumps provide avenues for termite, carpenter ant, and wood-boring beetle infestations. Trees and large shrubs may also provide roof rats, squirrels, and other animals nesting places and access to the upper portions of the building. Leaves clog gutters and can lead to water damage.

Mulch
Using termite-resistant mulches may reduce the incidence of termite activity; however, opinions vary on their effectiveness.

Maintain Buildings in Good Repair
The most effective indirect strategy for managing structural pests is keeping buildings in good repair. Keep the skin of the structure sealed using paint, putty, and caulk. Repair cracked foundations by injecting cracks with various materials (patching compounds). Cracks should be chiseled out to a ½-inch depth and ¼-inch width before patching. Injectable bonding materials have some elasticity to resist cracking, whereas cement mixes are likely to crack if soil heaving or settlement is causing ongoing foundation movement.

Inspect Lumber
Lumber and other wood items should be carefully examined for wood-boring beetle damage, such as small holes, sawdust, or fine wood fragments, before using or storing. Wooden furniture should be examined carefully for current beetle infestations before placement in the building.

Use Kiln-Dried or Air-Dried Lumber
Although close visual inspection of wood is essential, it is not a guarantee against beetle infestation. Some infestations can go undiscovered for years before damage is seen. Kiln-dried or air-dried lumber should be used in all construction projects.

Physical Controls

For termites, heavily damaged wood should be replaced with sound wood. Wherever possible, use lumber treated with wood preservatives such as borates (see Chemical Controls below). Dispose of infested wood as described above.

For wood-boring beetles, simply removing and replacing infested wood should be the first treatment option you consider. Carefully inspect wood in contact with the pieces that are removed to see if there is further infestation. In some situations, this may not be practical because the wood is inaccessible or labor costs are prohibitive. If any wood has been damaged to the point of structural weakness, it must be replaced or reinforced, no matter what treatment is used.

Chemical Controls

If nonchemical methods alone prove insufficient to solve the problem, then integrating a pesticide into your management program may be warranted. For information on pesticides and on how to select an appropriate pesticide for your situation, consult the Penn State Cooperative Extension office in your county.

Pesticides must be used in accordance with their EPA-approved label directions. **Pennsylvania law allows pesticide applications in schools only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator. The law also mandates a 7-hour reentry period for common access areas whenever pesticides are applied.** All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Do not apply these materials in common access areas when occupied, and never apply them where they might wash into a drain or sewer unless otherwise labeled.

Always post durable signs where pesticides have been used in attics and crawl spaces so that future inspectors and repair technicians can identify and avoid the areas where possible.

Borate-Based Wood Treatments (Subterranean Termites and Wood-Attacking Fungi)
Borates are fungicides and slow-acting insecticides. They are not repellent to insects (termites will construct tubes over borate-treated wood), but do act as anti-feedants, which means that pests prefer not to feed on wood treated with borates. When insects feed on wood treated with borate or, in the case of wood-boring beetles, chew emergence holes through treated wood, the borate acts as a stomach poison to kill the insects over a number of days. Borates also act as fungicides by inhibiting the growth of wood-attacking fungi.

Borates are used both in the pretreatment of lumber for the construction industry and in remedial treatment of lumber in existing buildings. Use pretreated lumber to replace existing lumber and prevent reinfestation in areas of potential termite activity or in areas vulnerable to rot. Crawl spaces and attics can be treated by a professional using a borate fogger, by spraying or painting liquid solutions directly on the wood, or by pressure-injecting the solution into the wood. A larger amount must be used in a fogger to get the same coverage as painting or spraying on the solution. Borates can be effective as an insecticide to eliminate small termite and wood-boring beetle infestations.

Since borates are water-soluble, they cannot be used to treat exterior wood unless the finish (paint or stain) or sealant is removed from the wood before treatment, and then a finish or sealant subsequently applied after treatment. Since borates can move easily through the soil and leach away from the area of application, they should not be used in close proximity to lakes, streams, ponds, or areas where there is standing water. High concentrations of borates are toxic to plants, so treatments of the perimeter of buildings can result in inadvertent poisoning of plants and shrubs near the building.

Desiccating Dusts Such as Diatomaceous Earth and Silica Gel (Wood-Boring Beetles)
Desiccating dusts can help prevent future infestations of wood-boring beetles. They are particularly useful in confined spaces such as attics and wall voids where they can remain effective for the life of the building. Desiccating dusts alone are effective and safe. They act primarily as physical, not chemical, agents, but they are commonly combined with pyrethrins.

Desiccating dusts act by abrading the oily or waxy outer layer that coats the body of an insect. Water inside an insect is contained by this waterproof coating, and loss of the coating leads to the death of the insect from dehydration.

Diatomaceous earth has been used against termites as a repellent, but the use of silica gel for termite control is more common. Diatomaceous earth can be easier to handle because it is composed of larger particles than the silica gel. It is important to note that the product described here is not the glassified diatomaceous earth used for swimming pool filters, but rather "amorphous" diatomaceous earth.

Termite Barriers

Using insecticides as termite barriers in the soil relies on uniform distribution in the soil. In some cases, soil characteristics or structural defects may prevent this, and barriers will fail. A pest management professional can provide conventional termite treatments. (For more information on this extensive process, refer to Mallis, 1997, pp. 285–298.)

Termite Baits (Subterranean Termites)

The termite baiting strategy involves two steps: finding termites by placing baits in appropriate sites and then exposing them to a slow-acting toxicant. The toxicant must be slow-acting so that termites have time to go back to the nest to spread the toxicant among their nest mates through food sharing and through mutual grooming. Since termites habitually wall off members of the community and/or galleries when they sense a problem with their food supply, the toxicant must work slowly enough that it goes undetected until a good portion of the colony has been exposed.

Baiting may eliminate a termite colony over a number of months (conventional chemical barrier treatments only try to prevent termites from entering a structure), but elimination may not be practical or necessary. Baiting is an ongoing process—you may eliminate one colony or portion of it, but another colony may eventually attack the structure in the future. Adequate control can probably be achieved by reducing the colony enough that no termites are seen in structures and no professional pest management call-backs are necessary.

Safety of Baits

Much smaller amounts of active ingredient are used in baits than are used in chemical barrier treatments, so there is less risk. Most of the active ingredients used in termite baits have low acute toxicity, and the concentrations in which they are used are generally low. Manufacturers are designing bait stations to be self-contained and tamper-resistant to protect children and animals from accidental exposure.

When to Bait

Because termite activity is seasonal, baiting is more effective at certain times of the year than other times. The best time to bait the eastern subterranean termite *(R. flavipes)* is in the late spring and early summer. Less activity is expected from November to February, although active termites have been found in bait stations in December and January.

Two Types of Baiting Strategies

There are two general types of food baiting that can be used: perimeter baiting or interceptive baiting. If the whereabouts of the termites are unknown, perimeter baiting is used. Wooden stakes, bait blocks, or plastic monitoring stations are set around the perimeter of a structure either in a continuous circle or in a grid pattern. Perimeter baiting relies on the certainty that termites foraging at random will eventually discover the bait. Once termites have been located, either by perimeter baiting or by finding shelter tubes or active galleries, interceptive baiting can be used. Here, actively foraging termites are intercepted with a bait. Interceptive baiting of structures has a disadvantage in that quite often termite damage already has been done, and even though the colony is eliminated, the wood may have to be replaced.

Inspection Checklist for Detecting Structural Decay and Pest Damage

INTRODUCTION

Check the following locations for structural decay and pest damage. Check both visually and by probing with a pointed tool, such as an ice pick (see page 90). Look for signs of moisture, damaged wood, insect frass, and termite earthen tunnels and/or fecal pellets.

ROOF, OVERHANGS, GUTTERS, EAVES, TRIM, AND ATTIC

Check the roof for cracks, missing shingles, and other openings where moisture might enter. Shingles should extend ¾ inch or more beyond the edge of the roof and should form a continuous drip line at the eave and end rafters, or at the rake boards that cover the end rafters.

Remove leaves from the roof surface, and replace any missing shingles. Install flashing or an aluminum drip edge under the first course of shingles to divert rainwater from the fascia board and walls of the building.

Be careful not to block eave vents. Install flashing; it should curl over the forward edge of the fascia board about 2 inches and then run about 6 inches beyond a vertical line drawn from the inside face of the wall studs.

Check for the formation of masses of ice on the roof near the gutters, which can lead to water filtration and/or excessive condensation on interior attic walls.

Gutters

Check for poorly sloped, clogged, rotted, or leaking gutters that can lead to eave, overhang, or siding leaks and rots. Remove leaves and twigs that absorb moisture and cause rot. Flush gutters with a hose before the rainy season. Install downspout leaf strainers and gutter guards.

Attics

Extra effort is needed to inspect areas that are difficult to see or reach. Use a good light source and a probe. Search for rain seepage or decay around vent pipes, antennas, wall-top plates, skylights, and other vents.

Eaves, Overhangs, and Fascia Boards

Make sure there is at least 18 inches of overhang to allow proper water runoff. Extend short overhangs. Search for soft, tunneled, cracked, or exposed areas. Check areas where algae, moss, lichens, or discoloration occurs; these symptoms may indicate moisture problems and termites.

Flashings

Make sure areas around vents, chimneys, and dormers are flush and well sealed. Rusty or broken nails can cause problems in flashings. Aluminum or galvanized nails are required to prevent electrolysis (a chemical reaction between dissimilar metals that causes the nails to disintegrate). Seal nail head and flashing joints with marine-quality caulk or silicone (tar preparations are cheapest, but they crack after a few years in the sun).

Damaged or Discolored Areas

Search for exposed areas that are soft, tunneled, cracked, rotted, or blistered. Check for algae, moss, lichens, or discoloration, since these areas indicate potential openings for fungi and/or insects. Locate the sources of moisture and make the necessary repairs.

OUTSIDE WALLS

Rusty Nails

Check for rusty nails or nail-staining, which indicates moisture within the wall and/or the use of nongalvanized nails. Replace rusty nails with aluminum or galvanized nails or screws.

Deteriorating Paint

Look for signs of deteriorating paint, such as loss of paint sheen and bubbling and peeling. Scrape and sand affected surfaces and repaint. If the wood seems soft, weak, or spongy, scrape out the spongy parts. If holes are smaller than ½ inch in diameter, fill them with caulk. Larger holes can be filled with epoxy wood-filler. If holes are very large, replace the wood.

Stained or Buckled Siding

Stained or buckled siding (with or without peeling paint) is a symptom of underlying moisture, rot, or insects. Check for moisture caused by splashing rain or lawn sprinklers. If possible, remove the source of the moisture and refinish or replace the damaged wood. Consider using a more durable material, such as aluminum siding. Pressure-treated woods are treated with toxic materials, and their use should be minimized.

Most of the information in this chapter is from *IPM for Schools: A How-to Manual*. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.

Damaged Wood Junctions

Moisture and insect problems often occur where wood pieces join or abut, particularly when there is shrinkage, splintering, or settling. Corners, edges of walls, roof/siding intersections, and siding/chimney contacts are particularly vulnerable. Apply water repellent and caulk to these joints, and monitor them regularly for building movement.

Weathering of Exposed Lumber/Beam Ends

Check for expanded, split, or cracked lumber ends, which provide access for moisture and insects. Even previously treated wood is subject to attack if the openings are deep enough. Caulk cracks and monitor for further developments.

Cracked or Loose Stucco

Search for cracks in stucco, especially stress cracks around windows and doors. These conditions can provide access to moisture, termites, and decay organisms. Caulk cracks. If they are large, consider replacing the old stucco.

Moisture Accumulation Around Laundry Facilities, Especially Dryer Vents

Check for signs of moisture accumulation around the vent. Modify the vent to direct exhaust air away from the building.

Moisture Associated with Pipes and Ducts

Check for moisture where ducts pass through wooden parts of a building. Also check downspouts during heavy rains for leakage and proper drainage. Insulate ducts, install splash guards below downspouts, repair the spouts, and direct water away from buildings.

Moist Window Sills, Windows, or Doors

Check for cracked sills and casings, and poorly fitted windows and doors. Badly fitted doors may indicate warping of the door or its casing from excessive moisture or uneven settling. Moisture problems can alter door jambs. Warped and cracked sills and poorly fitted windows and doors allow water access, which aids decay and provides initial insect habitat.

Caulk cracks and monitor for further development. Warped door thresholds and jambs may need replacement, and casings may need repair if the cracks are too large to caulk effectively.

FOUNDATION AND GRADE

Soil Surface

Make sure the soil surface slopes away from the school building in order to carry water away from the foundation. Seepage under the foundation will cause it to crack and settle. Add fill to direct the water away from the building, but make sure there is at least 8 inches between the top of the fill and the sill. If clearance is small, consider installing foundation "gutters." Install splash blocks and perforated pipe. Check their performance during rains, or test the system with a hose. A sump pump also can be used to move water away from the foundation.

Low Foundation Walls and Footings Allowing Wood-to-Soil Contacts

Check for wood in contact with the soil. Wood should be at least 8 inches, and preferably more, above the soil surface. Low foundation walls or footings often permit wooden structural members to come in contact with the soil, providing access for subterranean termites. Repair these areas or install subgrade concrete "gutters" where the building sills sit too close to ground level. Remove wood that comes in contact with the soil and replace it with concrete.

Foundation Cracks

Check for cracks that give decay organisms access to wood. Cracking may also indicate uneven settling. Monitor cracked walls for discoloration and seepage during rains. Termites use cracks to gain access to wood hidden from view. If the problem is serious, the foundation may need repair.

Brick Veneer or Stucco Applied to the Foundation

Check the bond between the veneer or stucco and the foundation wall. If it is failing, moisture and termites may have a hidden entrance to wooden portions of the building. Remove the loose covering and explore the extent of decay.

CRAWL SPACE, BASEMENT, AND FOUNDATION

Make sure enclosed crawl spaces are vented to allow moist air to escape. Milder climates are especially vulnerable to dry-rot fungus. In humid climates, the subfloor can be wet from condensation from interior air-conditioning. Shrubbery or other obstacles that block airflow through foundation vents cause air underneath the building to stay warm and moist—an ideal environment for termites.

Clean existing vents of dust, plants, and debris. Foundation vent openings should equal 2 square feet of

opening for each 25 linear feet of outside wall. An opening should occur within 5 feet of each corner. Add more vents if needed. The top edge of the concrete under all vents should be at least 6 inches above the finished grade to allow sufficient ventilation. Vents located below grade may require wells to prevent surface water from entering subfloor and basement areas. Divert roof drainage away from vents.

Corners of the Building

Check for moisture accumulation and stains at junctions of wood surfaces in these areas. Install additional cellar or crawl space vents.

Enclosed Areas

Check for proper ventilation under staircases, porches, and other enclosed areas, since these are vulnerable to moisture accumulation. Look for decayed, discolored, or stained areas. Adjust or add venting.

Vapor Barriers

Check for condensation on the subfloor and/or sill, which may indicate the need for vapor barriers on the subfloor and on the soil surface in the crawl space. Such barriers can be installed to reduce the moisture resulting from poor soil grading, unexpected seepage, or high rainfall.

Cover the crawl space soil surface with a 6-mil polyethylene vapor barrier. Use polyethylene instead of roofing paper, which can rot. A slurry of concrete can be placed over the plastic to protect it from rodents. Where condensation continues, consider installing extra vents or electric-powered vents whose fans and openings are operated automatically (Power Temp-Vents). A sump pump can be installed to remove standing water.

Wood-to-Stone or Wood-to-Concrete Contacts

Check to see whether the wood is pressure-treated (look for perforation marks from the chemical injection on the surface of the wood). Replace untreated wood with rot-resistant or pressure-treated wood. Be sure sealing material is used between the wood and stone or concrete, and place a metal washer between posts and footings.

Leaky Pipes or Faucets

Even small leaks keep the wood or soil underneath continuously moist, thereby setting up ideal conditions for termites. Areas where rain splashes on walls should be protected with rain guards. Do not allow sprinklers to spray the side of the building. Fix all leaks, and change irrigation practices where necessary.

Water- or Space-Heating Units

Check to see whether the heating unit is insulated. If the soil near the flame is kept warm throughout the year due to lack of insulation, microbial and insect development will be accelerated. Insulate the heater and cover the soil with concrete.

Paper Collars Around Pipes

Since paper is almost pure cellulose, it is extremely attractive to termites and should be removed and replaced with other insulating materials that termites can not eat.

Miscellaneous Openings

Meter boxes, bathroom inspection doors, pet doors or openings, milk delivery doors, and air exhaust vents should be checked for water access, cracks, termite pellets, and soft areas.

EXTERNAL AREAS

Porches

Check for wooden steps touching the soil, and inspect for possible decay or termite access. The porch surface must slope away from the building to carry rain away quickly. If the porch does not slope away from the building, check siding for moisture and termites. Tongue-and-groove flooring is a water trap.

If there is a space between the porch and the building, check for drainage problems.

Caulk and repair cracks. Fill spaces between tongue-and-groove floorboards with caulk or resurface and refinish with wood-sealing compounds and appropriate paint. Another floor can be placed over the first.

Earth-Filled Porches

Soil should be at least 8 inches, and optimally 12 to 18 inches, below the level of any wooden members. Remove the excess soil where possible, regrade to enhance drainage, and redesign the porch to eliminate earth/wood contact.

Planter Boxes

Check planter boxes that are built against the building. Move them 6 inches away from the building. If they are in direct contact with the building, they allow direct termite access to unprotected veneer, siding, or cracked stucco. One remedy is to allow a 6-inch space between the planter and the building to allow for air circulation and visual inspection. This air space must be kept free of debris.

Trellises and Fences

Check for wooden portions of the trellis that touch the soil and are connected to the building, since they provide a direct link to the building for wood rot and termites. Check fence stringers and posts for decay. Cut off the decay and install a concrete footing for trellises and fence posts. Replace decayed stringers and leave a small gap between the stringers to allow air circulation. Separate wood and concrete with metal washers.

Wooden Forms Around Drains

These are sometimes left in place after the concrete foundation is poured, providing termites with access routes to inner walls. Areas and joints around pipes rising from slabs should be sealed with tar or other adhesive to prevent water and termite access. Caulk the holes and monitor them for decay and excess moisture.

Gate Posts, Fence Tie-ins, Abutments, and Columns

Inspect these for weakness and rot, especially around areas adjacent to the soil. Exposed areas can provide cracks for termite invasion. If wooden posts go through concrete into the soil below, check the posts for evidence of termite attack. The bottoms of these posts should be cut and replaced with a concrete footing. Cut post tops at an angle to promote runoff and prevent water from penetrating the vulnerable end grain.

Balconies and Landings

Surfaces should be sloped away from the building. Check the junction of floor and siding for moisture and insects.

Wood Debris Under and Around Buildings

Pieces of wood, particularly partially buried tree roots or construction lumber, can help support a termite colony until the population grows large enough to attack the building itself. Since cardboard boxes are very attractive to termites, they should be removed from crawl spaces or basements with earthen floors.

INTERIOR LOCATIONS

Areas with water stains or mold growth indicate excessive moisture and should be analyzed for corrective action. Pay special attention to areas listed below.

Kitchen Pipes

Look for condensation and leaks, especially where pipes enter walls. Repair leaks and insulate pipes where condensation is excessive.

Counter Areas

Check around and below sink surfaces for moisture and decay. Caulk or otherwise protect wall surfaces from moisture. Subsurface areas damaged by water leaking from above may be tolerated if the surface leaks are repaired.

Exhaust Vents

Check for moisture leaks from outside. Repair with caulk or water-resistant sealing material, or replace the vent and the rotted wood around it. Use extra flashing to fill the gap.

Toilets

Check the integrity of the floor around each toilet base by thumping lightly with a hammer. Check the wax seal for leakage at the floor/toilet pedestal intersection. If you detect leakage, check the cellar or crawl space beneath the toilets to see whether it has caused damage. Replace the wax seal if necessary, and repair the surrounding water damage.

Showers and Sinks

Check all sinks and showers for a sound caulk seal. Look for splash-over on the floors from inadequate water barriers or user carelessness. If moisture is visible from crawl spaces, it may indicate a crack in the floor or in drainage pipes. If moisture is visible in the ceiling, it may indicate cracks in the delivery pipes.

Repair or replace flooring materials, pipes, drains, or sink basins if necessary. Sealing compounds may be useful when leaks are relatively recent and small, especially if termites have not been found; however, regular monitoring is necessary if sealing materials are used.

Tile Walls

Check for mildew stains. Make sure the grout in tile walls has a silicone coating to prevent water penetration. Clean the walls regularly to remove mildew and improve ventilation.

Ceilings

Check for blistered areas, since these can indicate moisture leaks in the area above or inadequate installation of a vapor barrier. Repair leaks and faulty vapor barriers.

Windows

Check for moisture accumulation and/or water stains on window frames and walls. Search for evidence of decay or insect attack next to glass areas where condensation accumulates, at edges where moldings meet walls and casings, and in window channels and door jambs.

Gaps between window and door casings may be avenues for hidden moisture and insect access. Check interior walls beneath windows, especially if they are regularly wetted by garden sprinklers.

Open windows when feasible to improve air circulation. Install double- or triple-glazed windows when replacement is necessary. Use aluminum frames if wooden frames are decaying. Adjust or move sprinklers so water does not hit windows.

Closets

Check coat and storage closets for dampness. A light bulb left burning continuously in a damp closet often will generate enough heat to dry it out, but make sure the bulb is far enough away from stored materials to avoid creating a fire hazard. Containers of highly absorbent silica gel, activated alumina, or calcium chloride also remove moisture from the air in enclosed spaces. These agents should be placed out-of-reach to avoid accidental exposures. Avoid use of silica gel where children may tamper with the containers. These chemicals can be reused after drying them in the oven. Small exhaust fans also can improve closet ventilation.

Floors

Sagging or buckling floors can indicate shrinkage or rot from excessive condensation or water leaks. Gaps between floor and baseboards can indicate wood damage from insects, fungi, or water-triggered swelling and shrinkage.

IPM for Yellowjackets and Hornets in Schools

INTRODUCTION

Yellowjackets and hornets are both beneficial and problematic wasps. They are important predators and scavengers, helping to manage pests and recycle organic materials, but they also can sting humans and their pets. Although often grouped together with bees, yellowjackets pose a more serious threat to people. Yellowjackets can sting repeatedly, while a bee can sting only once. Multiple stings from yellowjackets are common, because they aggressively defend their nest when it is disturbed.

IDENTIFICATION AND BIOLOGY

"Yellowjacket" and "hornet" are the common names given to wasps in the genera *Dolichovespula*, *Vespula*, and *Vespa*; but for the sake of simplicity, the term "yellowjacket" will be used. Note that these common names are not reliable indicators of whether or not they are pests.

Yellowjackets are relatively short and stout, and hold their legs closer to their bodies than other wasps do. Paper wasps are more slender and have long dangling legs. All yellowjackets are either black and white or black and yellow. They are rapid fliers, and are more aggressive than other types of wasps. Their nests are always enclosed with a papery envelope and can be found in the ground, hanging from eaves or tree branches, and occasionally in wall voids.

The queen begins her nest by building a small comb of chewed wood. She lays eggs in the cells and, after the eggs hatch, tends the larvae herself. Once the larvae develop into adult workers, they expand the nest into tiers, built one on top of the other. In the late summer or early fall, males and new queens are produced. After mating, the queens seek a sheltered place to spend the winter and all the workers die. The nest is not reused and eventually disintegrates.

Early in the warm season, colonies are small and yellowjackets are usually not a problem. Later in the season, when colonies are at their peak, these insects become pestiferous. In their search for protein and carbohydrate sources, they are attracted to garbage cans, dumpsters, lunch counters, and playgrounds, where they scavenge for food.

TABLE 9.

Distinguishing Among Bees, Wasps, Yellowjackets, and Hornets

Name	Appearance	Habits	Nests	Feeding Behavior
Bees	Hairy, stout bodies with thick waists; workers and reproductives are winged	Noisy flight; sting mainly while defending nest; foraging workers seldom sting	In hives, trees, or buildings	Collect pollen and nectar; feed pollen to young and share food with other adult bees
Solitary wasps	Thin- or thick-waisted	Visit flowers and other vegetation; relatively docile	In mud, or in holes in ground	Predators; provision nests with prey for young to feed on
Yellowjackets and hornets	Stout, colorful; mostly black and yellow or black and white	Rapid fliers; aggressive individuals capable of inflicting multiple stings; social in large colonies, which they defend vigorously	Multilayered, papery nests mostly in ground, although some aerial or in structures; nests have an outer papery covering called an "envelope"	Mostly beneficial predators, but scavenger species become pestiferous
Paper (umbrella) wasps	Long bodies with thin waists, long dangling legs	Social; search vegetation for prey; visit flowers for nectar; not particularly aggressive	Single layered, papery nests without an envelope; attached to fences, eaves, boards, branches; shaped like an umbrella	Beneficial predators; feed prey to developing young in nest

Adapted from the *IPM for Schools: A How-to Manual*. United States Environmental Protection Agency. EPA 909-B-97-001. March 1997.

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STINGS

Insect stings are the leading cause of fatalities from venomous animals in the United States. The people who die from yellowjacket or bee stings are people who experience large number of stings at once or who suffer severe allergic reactions to the inflammatory substances in the insect venom. These allergic reactions include soreness and swelling, not only at the site of the sting, but also on other parts of the body that may be distant from the site. Other symptoms include fever, chills, hives, joint and muscle pain, and swelling of the lymph glands and small air passageways. In severe cases, the individual may suffer a sudden drop in blood pressure and lose consciousness. While many individuals who experience allergic reactions have become sensitized over time by previous stings, half of all fatalities occur in individuals stung for the first time.

Ordinary reactions to stings include localized pain, itching, redness, and swelling for hours to a day or two after the event.

NEST DISTURBANCE

Yellowjackets that are foraging for food usually will not sting unless physically threatened, such as being squashed or caught in a tight place. But if they feel their nest is in danger, they will vigorously defend it. All wasps defend their colonies, but some yellowjackets are more sensitive to nest disturbance and more aggressive in their defense. Disturbing a yellowjacket nest can result in multiple stings. This can occur when someone accidentally steps

Avoiding and Treating Stings

Children should be taught to stay calm when confronted by a foraging yellowjacket, because quick, jerky motions will frighten wasps and make them more likely to sting. Stillness, or slow, gentle movements, will greatly decrease the probability of being stung. Slowly and carefully brushing off a yellowjacket that has landed on someone, or waiting until it flies off, is better than hitting or constraining it since aroused yellowjackets will sting. Avoid smashing yellowjackets, because when crushed they give off an alarm pheromone that can cause other yellowjackets to attack.

If soft drinks or fruit juices are being consumed on school grounds where there are many yellowjackets, warn children to look into their cups or cans before each sip, because someone can accidentally drink in a wasp and get stung in the mouth or throat. Tell them not to panic if they find a wasp taking a drink. Ideally, all sweet drinks should be in containers with secured lids, and the children can use straws for drinking. It may become necessary to prohibit eating and drinking outside during the peak of the yellowjacket season.

First Aid for Stings

- If the sting is to the throat or mouth, medical attention must be sought immediately, because swelling in these areas can cause suffocation. *Dial 911 immediately* and give the victim an ice cube to suck.

For hypersensitive individuals

- Anyone who is hypersensitive or who experiences difficulty breathing, wheezing, fainting, dizziness, or color changes (turning blue) should be treated by the school nurse and taken to a hospital emergency room immediately. The nurse should have an emergency kit containing preloaded syringes of epinephrine for use with hypersensitive individuals.
- Keep the affected portion of the body below the level of the victim's heart.

For all others

- Wash the area around the sting with soap and water and apply an antiseptic. Washing can help remove the venom from the wound, which will help reduce the pain and swelling from the sting.
- As soon as possible, treat the sting either with ice contained in a cloth or plastic bag or with commercially available products for easing the pain of wasp or bee stings. Ice will help reduce the swelling, and the commercial products will relieve both pain and swelling. Some people claim a paste made of meat tenderizer helps reduce swelling and pain.
- Antihistamines given every few hours, according to label directions, also can prevent pain and swelling.

Have the victim rest.

Do *not* administer sedatives.

on an underground nest opening or disturbs a nest in a shrub or building. Sometimes merely coming near a nest, especially if it has been disturbed previously, can provoke an attack.

Underground nests can be disturbed simply by vibrations. Thus, mowing lawns or athletic fields can be hazardous, and operators may need to wear protective clothing when mowing during the late summer season when colonies are large. It can be very frightening to be the victim of multiple wasp stings. If there are only one or two wasps, back slowly away from them until they stop attacking you. Otherwise, it is best to run away from a colony rapidly, protecting your face and eyes as much as possible.

It is important to educate children about the beneficial role of these wasps (they feed on pest insects, particularly caterpillars) and to remind them repeatedly of ways to avoid stings. Since problems with yellowjackets are most common in late summer and fall, teachers can be provided with this information at the beginning of the fall term. See the box on page 100 for tips on avoiding and treating stings.

DETECTION AND MONITORING

If there is a chronic problem with yellowjackets around outdoor lunch areas or school athletic fields, inspect the area methodically to locate the nests. Nests can be found in the ground, under eaves, and in wall voids of buildings. Ground nests are frequently—but not always—located under shrubs, logs, piles of rocks, and other protected sites. Entrance holes sometimes have bare earth around them. Nest openings in the ground or in buildings can be recognized by observing the wasps entering and leaving.

MANAGEMENT OPTIONS

The objective of a yellowjacket management program should be to reduce human encounters with the wasps, but not to eliminate them from the entire area since they are beneficial predators of insects. The two most productive and least environmentally destructive ways to do this are to modify the habitat to reduce yellowjackets' access to food in the vicinity of human activities, and to use physical controls such as trapping and nest removal. Area-wide poison baiting should be used only as a last resort when other methods have failed and stings are frequent.

Physical Controls

Habitat Modification

Garbage containers on school grounds should have tight-fitting lids. The cans should be emptied frequently enough to prevent the contents from impeding the closure of the lid. The lids and cans should be periodically cleaned of food wastes. Disposable liners can be used and replaced when soiled or damaged.

When these practices are not followed, school garbage (and the flies around it) becomes a food source for yellowjackets in the area. If a large number of wasps are around garbage containers, students may be afraid to get close enough to place garbage all the way inside, and spilled food will attract more wasps.

Dumpsters should be cleaned frequently by washing them with a strong stream of water. If the dumpster service company has a cleaning clause in their contract, make sure it is enforced.

To limit yellowjacket infestations inside the school buildings, repair windows and screens and caulk holes in siding. Building inspections for yellowjackets can be done at the same time as inspections for other pests, such as rats, mice, and termites. Inspections should be conducted monthly to ensure that developing nests are found before they get large enough to be problematic.

Trapping

Trapping with a sturdy trap and an attractive bait can significantly reduce yellowjacket numbers if a sufficient number of traps are used. There are a variety of traps on the market. In general, cone-type traps are more useful for long-term trapping that will last many weeks. In some schools, unbaited yellow sticky traps (like those used to catch whiteflies) affixed to fences near underground nests have provided sufficient management to protect children from stings.

A homemade, cone-type fly trap can be used to catch yellowjackets simply by using the captured flies inside the trap as bait. (See page 53 for instructions on making the fly trap). The yellowjackets enter the trap to get the flies and become trapped themselves (see Tips on Trapping Yellowjackets in a Homemade Cone-Type Fly Trap on page 102). If you use baits such as dog food, ham, fish, or other meat scraps, or fermenting fruit and jelly, **make sure the traps are placed in areas inaccessible to students, because large numbers of yellowjackets may be attracted to the baits.**

However, the traps should be placed near the nest if it can be found, and/or near the area where the yellowjackets are troublesome. Teachers can be instructed to make a short presentation on the purpose of the traps to satisfy the curiosity that students will undoubtedly have. Show students the traps, explain how they work, and try to impress upon them the importance of the traps in maintaining the safety of the playground. Then be sure to move the traps to an area inaccessible to students.

When traps are full they can either be placed in a freezer for a day to kill the wasps or enclosed in a heavy-duty plastic garbage bag and placed in the direct sun for several hours. A third way of killing the wasps is to submerge the traps in a bucket of soapy water until the wasps drown.

The traps should be out only during the period that yellowjackets are a problem, usually late summer and early fall. When the traps are taken down for the year, they should be cleaned with soap and water and stored.

Tips on Trapping Yellowjackets in a Homemade Cone-Type Fly Trap

Yellowjackets can be caught in a cone-type fly trap using only the trapped flies as bait. The following tips will help improve yellowjacket trapping:

- Use this trapping method where students cannot gain access to the traps or at a time when students are not in school.
- Mix the fly bait according to the instructions on pages 54 and 55.
- Set up the fly trap with the fly bait in the area where the yellowjackets are a nuisance.
- If the trap is still attracting only flies after a day or two, move the trap to a new spot around the perimeter of the nuisance area.
- If your trap stops catching yellowjackets at some point, but is still catching flies, try switching to a sweet bait such as fruit punch or jam.

Note: To avoid being stung, you should replenish the fly bait or move the trap in the cool parts of the day—early morning or late evening. To kill everything in the trap before emptying, put the trap into a large plastic garbage bag and seal the bag. Place the bag in direct sunlight for several hours or in a freezer overnight.

Nest Removal

A nest can be destroyed through physical removal (vacuuming) or by using a pesticide (see Chemical Controls). Either way, great care must be exercised, because any disturbance around a nest can cause multiple stings. It is best to have a pest management professional or other experienced person remove the nest. Nest removal should take place at night, when the children are out of school and the yellowjackets are in the nest. When illumination is needed, use a flashlight covered with red acetate film so it will not disturb the wasps.

Adequate protective clothing and proper procedures can minimize problems and stings. It is important to wear protective clothing when removing wasp nests. Complete body coverage is essential, because yellowjackets and other wasps can find even the smallest exposed area. Use clothing made for beekeepers. This includes:

- A bee veil or hood that either contains its own hat or can be fitted over a light-weight pith helmet or other brimmed hat that holds the veil away from the head. A metal-screen face plate that extends around the head is a desirable feature. Check the veil carefully for tears before each use.
- A bee suit or loose-fitting, heavy-fabric coverall with long sleeves. This is worn over regular pants and a long-sleeved shirt to provide extra protection from stings.
- Sturdy, high-topped boots. Secure pant legs over the boots with duct tape to prevent wasps from getting into trousers.
- Gloves with extra-long arm coverings so sleeves can be taped over them to protect the wrists.

Vacuuming

Vacuuming out entire nests is not recommended unless it is done by a pest management professional experienced in handling stinging insects.

Vacuuming is particularly effective when nests occur in wall voids, in emergencies where nests have already been disturbed, and in environmentally sensitive areas where nests should not be treated with insecticides.

Some pest management professionals in some cities will perform this service for free so they can collect the wasps to sell to pharmaceutical companies for their venom. If the school is interested in this option, take time to find a company that will perform this service for you.

Chemical Controls

If nonchemical methods prove insufficient to solve the problem, then integrating a pesticide into your management program may be warranted.

Pesticides must be used in accordance with their EPA-approved label directions. Applicators should always wear protective gear during applications. All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. **Pennsylvania law allows pesticide applications in schools only by certified applicators, registered technicians, or by noncertified applicators or nonregistered technicians under the direct supervision of a certified applicator. The law also mandates a 7-hour reentry period for common access areas whenever pesticides are applied.**

When an insecticide is considered necessary for the management of yellowjackets, the best approach is to confine it to the nest itself. Anyone applying insecticides should use special clothing that protects against the chemical as well as against wasp stings. Insecticides should be applied in the evening or very early morning when children are absent, the wasps are inside the nest, and cooler temperatures reduce insect activity.

A number of insecticides are registered for use against yellowjackets. The following are most appropriate for use in schools:

Silica Aerogel and Pyrethrins
Silica aerogel combined with pyrethrins is an effective insecticidal dust that can be used to destroy an underground nest or a nest in a wall void. Silica aerogel is made from sand and works by abrading the outer waxy coating on insect bodies. Once this coating is damaged, the insects cannot retain water and die of dehydration.

Products with Components That "Freeze" Wasps
Pyrethrins can be used to quickly knock down guard wasps at the nest entrance and to kill yellowjackets in an aerial nest when they must be destroyed in the daytime. These aerosol products are designed to project a stream of spray 10 to 20 feet and contain highly evaporative substances that "freeze" or stun the yellowjackets.

Do Not Use Gasoline
Gasoline should never be poured into underground nest holes. This dangerous practice creates a fire hazard, contaminates the soil, and prevents the growth of vegetation for some time. A ground application of gasoline poses greater harm to children and the environment than a yellowjacket nest.

Avoid Area-Wide Control Measures
Mass control measures are seldom, if ever, necessary, and they are expensive due to the labor involved in the frequent mixing and replacement of bait. The effectiveness of bait mixtures is also questionable, since the baits face considerable competition from other food sources that are more attractive to scavenging yellowjackets.

Literature Citations and Additional References and Resources for School Integrated Pest Management

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Videos

Videos with a PDA number after them may be borrowed from the Pennsylvania Department of Agriculture. Direct requests to:

The Pennsylvania Department of Agriculture
Bureau of Plant Industry/Pennsylvania IPM Program
2301 North Cameron Street, Rm. G11
Harrisburg, PA 17110-9408
(717) 772-5204

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Vol. 3. Control of the house mouse. 60 min. (PDA-C3).
Vol. 4. Biology of subterranean termites. 60 min. (PDA-C4).
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3. IPM for food handling areas. Time: 16 min. (PDA-L9).
4. Bidding and contracting for pest control in schools. Time: 17 min. (PDA-L10).
5. The challenge of administering pest control in schools. Time: 17 min. (PDA-L11).

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Carpenter ants. Time: 29 min. (PDA-E1).
Safety with pesticides. Time: 15 min. (PDA-E2).
Stinging insects. Time: 20 min. (PDA-E3).
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Web Sites

EPA. *IPM for Schools: A How-to Manual*, includes complete EPA Manual, downloadable as PDF files. **http://www.epa.gov/region09/toxic/pest/school/index.html**

The IPM Institute of North America, Inc. Web site with extensive school IPM information as well as IPM Standards, pest control, links, etc. **http://www.ipminstitute.org/**

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The Pennsylvania State University Entomology Department Insect Pest Fact Sheets. **http://www.ento.psu.edu/extension/fact_sheets.htm**

The Pennsylvania State University Ornamental Plant Disease Fact Sheets. **http://www.cas.psu.edu/docs/CASDEPT/PLANT/ext/factl.html**

The Pennsylvania State University Turfgrass Extension Program. **http://www.agronomy.psu.edu/Extension/Turf/TurfExt.html**

University of Florida. Web site with excellent information for school IPM. **http://schoolipm.ifas.ufl.edu/**

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Supplemental Materials to Help Develop IPM Programs in Pennsylvania Schools

PESTICIDE RULES AND REGULATIONS IN PENNSYLVANIA SCHOOLS

The following information is excerpted from the publication **PENNSYLVANIA PESTICIDE CONTROL ACT OF 1973, Act of March 1, 1974, P.L. 90, No. 24, 3 P.S. 111.21-111.61 (1987)**. For complete text refer to the actual publication. Copies are available from the Pennsylvania Department of Agriculture, 2301 North Cameron Street, Harrisburg, PA 17110-9408.

In order to apply pesticides in a school or on school grounds, the applicator needs to be a **Certified Public/ Commercial Applicator** [Section 17.1], a registered **Pesticide Application Technician**, or a non-certified applicator or non-registered technician **under the direct supervision of a Certified Applicator**. [Sections 16.1 and 16.2].

Pesticide in this document means any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, and any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant. [Section 4 (31)].

For in-house pest control, Section 15.1 applies. **Pesticide Application Licensing**. Each ... government agency or other entity engaged in applying or contracting for the application of pesticides, as meets the definition of "commercial applicator," shall hold a license stating those categories in which it is to do business. No license shall be issued to any ... agency, nor shall any license remain valid unless such ... agency has a certified applicator in its employ at all times.

Sections 29 and 30.1 provide for Criminal Penalties and Civil Penalties for violation of the above regulations.

The next section is from the publication **TITLE 7—AGRICULTURE, DEPARTMENT OF AGRICULTURE, PART V. BUREAU OF PLANT INDUSTRY, [7 PA. CODE CH. 128], PESTICIDES, RULES AND REGULATIONS**. (The second part of the reference listed at the end of this article).

Definitions from § 128.2:

Common access area—The areas within a school building where students/attendees normally congregate, assemble or frequent during normal academic instruction or extracurricular activities. The term does not include areas such as kitchens, boiler rooms, utility/maintenance rooms and areas which are physically blocked or restricted from student/attendee access.

Current registry—The Pesticide Hypersensitivity Registry with the most recent effective date.

Governmental entity—Any executive or independent agency or unit of the Commonwealth, or local agency, including a county, a city, a borough, town, township, school district, municipal authority, or political subdivision thereof.

Integrated pest management—The managed use of combined pest control alternatives, including cultural, mechanical, biological, and chemical, to most effectively prevent or reduce to acceptable levels damage caused by pests.

Pesticide hypersensitivity—Excessive or abnormal sensitivity to pesticides.

School—A public, nonpublic, or licensed private elementary or secondary school wherein a resident of this Commonwealth may fulfill the compulsory school attendance requirements and which meets the applicable requirements of Title IV of the Civil Rights Act of 1964 (42 U.S.C.A. § 2000c) (Public Law 88-352, 78 Stat. 241). The term also includes a kindergarten or preschool program operated by a school and a child day care center operating under a certificate of compliance issued by the Department of Public Welfare.

§ 128.41. Requirements for Certification.

(a) A person is deemed to be a commercial or public applicator and required to be certified if one or more of the following criteria are met:

(3) A person who applies or supervises the application of a pesticide to the following locations or who is involved in the following types of application:

(i) *Fumigation.*

(v) *Playgrounds and athletic field*—Includes a person who applies a pesticide to a public playground or an athletic field.

(vii) *Schools*—Includes a person who uses a pesticide on school property, except for the use of disinfectants and sanitizers within the school building.

§ 128.42. Categories of Commercial and Public Applicators.

(11) *Household and health related*—The use of a pesticide in, on or around a food handling establishment, a human or nonagricultural animal dwelling, an institution such as a school or hospital…

(12) *Wood destroying pests*—The use of a pesticide to control or prevent termites, powder post beetles or other wood destroying pests infesting a residence, school, hospital, ... and an area adjacent to those structures.

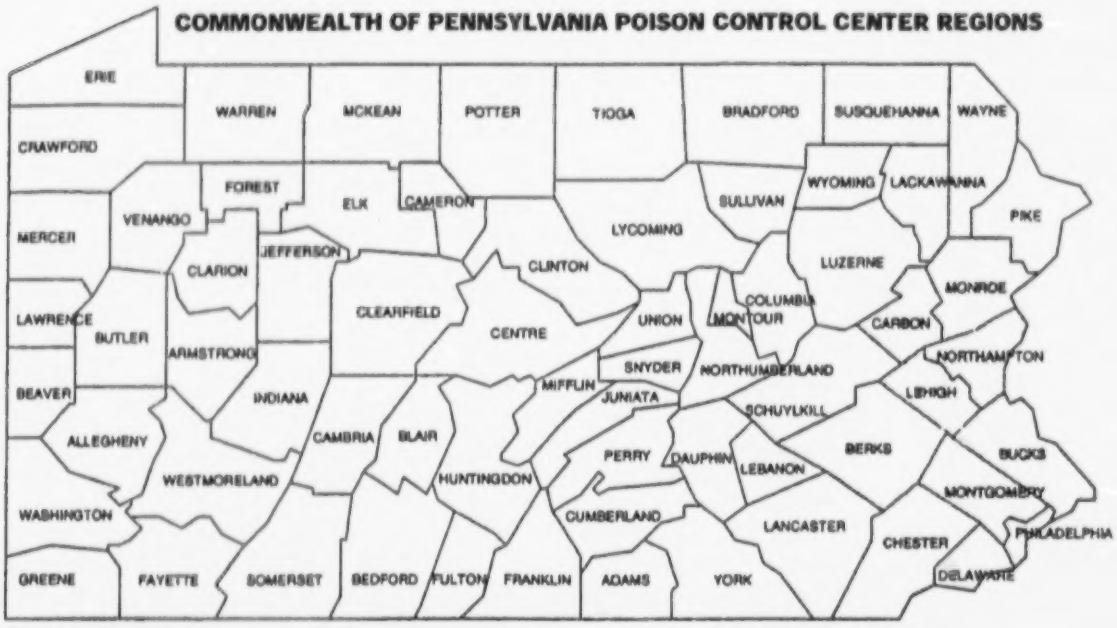
(23) *Park or school pest control*—The use of a pesticide in a campground or recreational area of a public or private park or on school property. *(This category is recommended for in-house personnel).*

§ 128.106. Additional Responsibilities within School Buildings.

A pesticide other than a disinfectant or sanitizer may not be applied in a common access area within a school building when students are expected to be in the common access area for normal academic instruction or organized extracurricular activities within 7 hours following the application. The applicator shall also comply with reentry time restrictions contained on the pesticide label, whichever is greater.

Reference: PENNSYLVANIA PESTICIDE CONTROL ACT OF 1973, Act of March 1, 1974, P.L. 90, No. 24, 3 P.S. 111.21-111.61 (1987) and TITLE 7—AGRICULTURE, DEPARTMENT OF AGRICULTURE, PART V. BUREAU OF PLANT INDUSTRY, [7 PA. CODE CH. 128], PESTICIDES, RULES AND REGULATIONS. (Available from the Pennsylvania Department of Agriculture, Bureau of Plant Industry, 2301 N. Cameron St., Harrisburg, PA 17110-9408.

COMMONWEALTH OF PENNSYLVANIA POISON CONTROL CENTER REGIONS



Pittsburgh Poison Center
Area: Western Pennsylvania
Children's Hospital of Pittsburgh
3705 Fifth Avenue
Pittsburgh PA 15213
Emergency Phone:
1-412-681-6669
AAPCC Certified*

Central Pennsylvania Poison Center
Area: Central Pennsylvania
The Milton S. Hershey
Medical Center
Hershey PA 17033
Emergency Phone:
1-800-521-6110
AAPCC Certified*

The Poison Control Center
Area: Southeast Pennsylvania, Lehigh Valley
Children's Hospital of Philadelphia
3600 Sciences Center, Suite 220
Philadelphia PA 19104-2641
Emergency Phone:
1-800-722-7112
AAPCC Certified*

* Certification by the American Association of Poison Control Centers requires that poison centers be staffed by registered nurses, be open 24 hours a day, and serve a large enough area of population.

SUPPLEMENTAL MATERIALS AVAILABLE

Penn State Cooperative Extension Offices and/or the Pennsylvania Department of Agriculture.

Booklice. 1998. Penn State Department of Entomology Pest Sheet. 1 p.

Carpenter ants. 1995. Penn State Department of Entomology Pest Sheet. 2 pp.

Chinch bugs. 1992. Penn State Department of Entomology Pest Sheet. 2 pp.

Clothes moths. 2000. Penn State Department of Entomology Pest Sheet. 2 pp.

Developing an integrated turfgrass pest management program. 1993. Penn State Cooperative Extension. 10 pp.

Eastern subterranean termites. 1992. Penn State Cooperative Extension. 6 pp.

Identifying common household insects in Pennsylvania. 2000. The PA IPM Program. 6 pp.

Managing turfgrass diseases. 1997. Penn State Cooperative Extension. 23 pp.

Moth flies in the home. 1998. Penn State Department of Entomology Pest Sheet. 1 p.

Pavement ant. 2000. Penn State Department of Entomology Pest Sheet. 2 pp.

Pennsylvania Pesticide Control Act of 1973, Act of March 1, 1974, P.L. 90, No. 24, 3 P.S. 111.21-111.61 (1987) and Title 7–Agriculture, Department of Agriculture, Part V. Bureau of Plant Industry, [7 Pa. Code Ch. 128], Pesticides, Rules and Regulations. Pennsylvania Department of Agriculture. 29 pp.

Silverfish. 1998. Penn State Department of Entomology Pest Sheet. 1 p.

Sod webworm. 1992. Penn State Department of Entomology Pest Sheet. 2 pp.

Weed management in turf. 1994. Penn State Cooperative Extension. 27 pp.

White grubs in home lawns. 1990. Penn State Department of Entomology Pest Sheet. 2 pp.

County Extension Offices

List of county offices is available at: **http://www.extension.psu.edu/CountyList.html**

Pennsylvania Department of Agriculture Regional Offices

List and map of regional offices is available at: **http://sites.state.pa.us/PA_Exec/Agriculture/main/regions/index.htm**

NOTES: